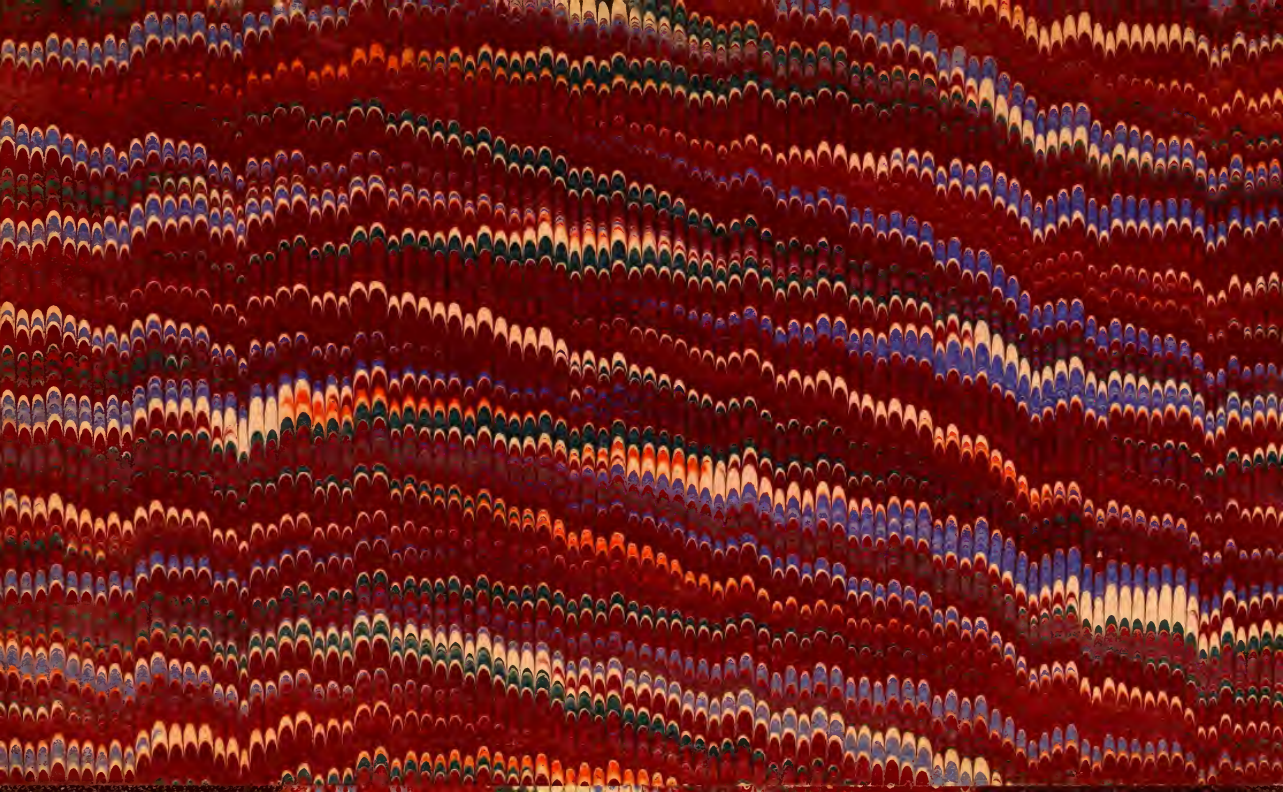

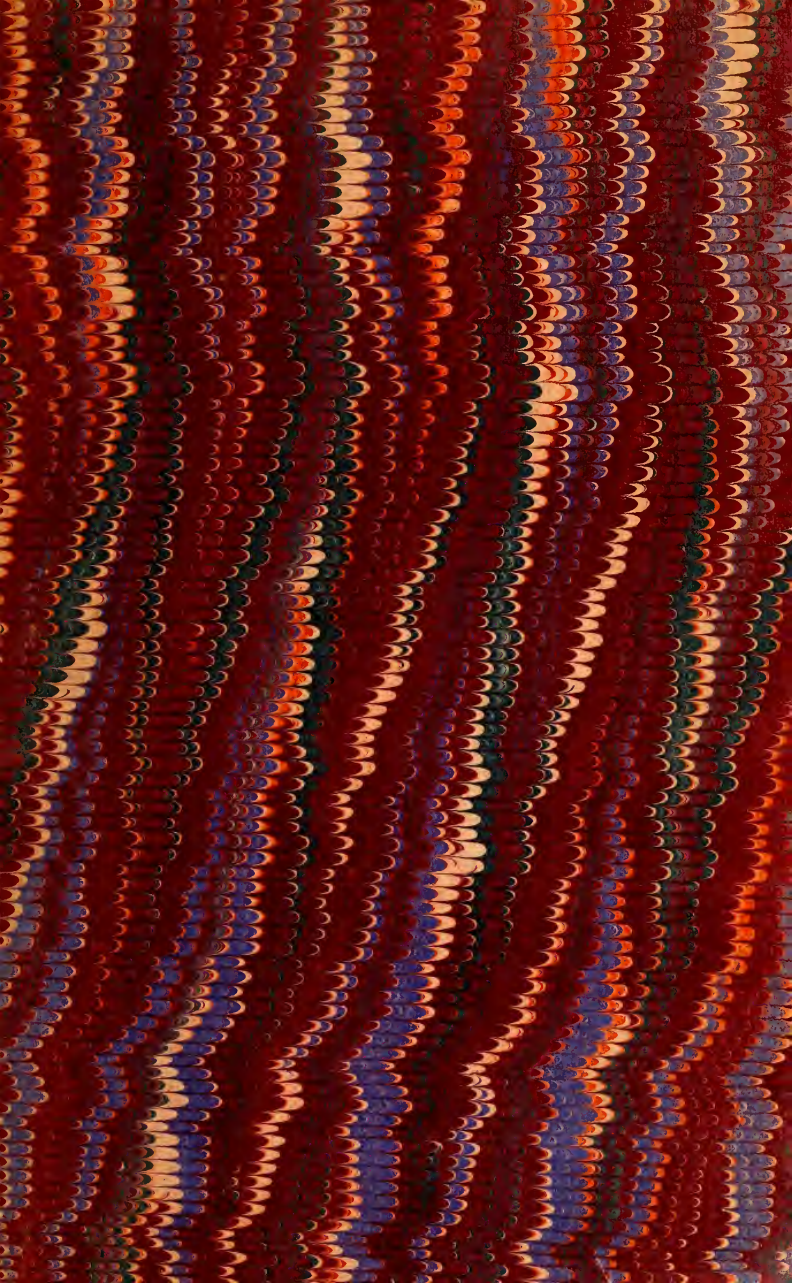

Division of Fishes
U. S. National Museum

AMERICAN FISHERIES SOCIETY.

1885.

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TRANSACTIONS

—OF THE—

AMERICAN

FISHERIES & SOCIETY,

Fourteenth Annual Meeting,

Held at the National Museum, in Washington, D. C.

MAY 5TH AND 6TH, 1885.

NEW YORK.

1885.

OFFICERS FOR 1885—86.

PRESIDENT, COL. M. McDONALD, - - *Berryville, Va.*

VICE-PRESIDENT, DR. W. M. HUDSON, - - *Hartford, Conn.*

TREASURER, E. G. BLACKFORD, - - *Brooklyn, N. Y.*

REC. SEC. - FRED MATHER, - *Cold Spring Harbor, N. Y.*

COR. SEC. - W. V. COX, - *National Museum, Washington.*

EXECUTIVE COMMITTEE.

PROF. G. BROWN GOODE, *Chairman*, - - *Washington, D. C.*

ROLAND REDMOND, - - - - *New York City.*

GEORGE SHEPARD PAGE, - - - - *Stanley, N. J.*

W. L. MAY, - - - - - - *Fremont, Neb.*

F. N. CLARK, - - - - - *Northville, Mich.*

DR. J. A. HENSHALL, - - - - *Cynthiana, Ky.*

S. G. WORTH, - - - - - *Raleigh, N. C.*

Proposed Constitution.

The Committee appointed by the President to revise the Constitution, offered the following to be considered until the next meeting, when it will be voted upon.

ARTICLE I.—Name and Objects.

The name of this Society shall be "The American Fisheries Society." Its object shall be to promote the cause of fish-culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of the interests of fish-culture and the fisheries; and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II.—Members.

Any person shall, upon a two-thirds vote and a payment of three dollars, become a member of this Society. In case that members do not pay their fees and are delinquent for two years, they shall be notified by the Treasurer, and if the amount due is not paid within a month, they shall be, without further notice, dropped from the roll of membership. Any person can be made an honorary or a corresponding member upon a two-thirds vote of the members present at a regular meeting.

ARTICLE III.—Officers.

The officers of this Society shall be a President and a Vice-President, who shall be ineligible for election to the same offices until a year after the expiration of their terms, a Corresponding Secretary, a Recording Secretary, a Treasurer, and an Executive Committee of seven, which with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session; fou to constitute a quorum.

ARTICLE IV.—Meetings.

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or in default of such action, by the Executive Committee.

ARTICLE V.—Changing the Constitution.

The Constitution of the Society may be amended, altered or repealed, by a two-thirds vote of the members present at any regular meeting.

Signed, Fred Mather, *Chairman.*
W. V. Cox,
F. N. Clark,
Committee.

Fourteenth Annual Meeting

OF THE

American Fisheries Society.

(AMERICAN FISH-CULTURAL ASSOCIATION.)

FIRST DAY.

THE Fourteenth Annual Meeting of the Society, and the first under the new name, was held in Washington, in the lecture room of the National Museum, on May 5th and 6th. The meeting was called to order at 12 M. on the 5th, by the President, Hon. Theodore Lyman, of Massachusetts, with the following remarks:

GENTLEMEN OF THE AMERICAN FISHERIES SOCIETY: We are at a season of the year when important events repeat themselves. It is the spring. Baneful influences have passed away. Ice-bound winter, as by a miracle, has given place to southern breezes, and—still more strange—Congress has adjourned and gone home. Good things come to the front, full of hope and energy, and intent on growth and reproduction. Asparagus protrudes its welcome green nose from the soil; the suggestive pea flourishes defiant of late frosts. The English sparrow industriously builds its nest in spots carefully selected to render it as much a nuisance as possible; the cows go forth to pastures green and reward the aqueous milkman with abundant flow of milk pleasingly redolent of garlic. Nor do the waters less respond to genial warmth; for now the shad and the herring,

intent on spawning and oblivious of the fatal seine, push up the Potomac and seek the safe shores of the District of Columbia, where they may breed under the parental protection of a special act of Congress. Last and greater than all these come the members of the American Fisheries Society, pregnant with great ideas and anxious to deposit them in Washington for the benefit of an ichthyophagous nation.

Gentlemen, I bid you welcome. You are surrounded here by great traditions and mighty influences. From the capstone of yonder monument ten entire weeks look down upon you. In the grand pile of the War, State and Navy Departments, you will have a valuable lesson of what is to be avoided in architecture. The hurrying crowds of office-seekers will prove to you how the busiest bee may, under adverse circumstances, collect no honey, and how the earliest bird may fail to catch the truly astute and resolute worm. The numerous "hansom" and "herdic" cabs will point the moral, that however long or agreeable or smooth be the road, we must all pay a price at the end. The suave manners of our negro population will bring to your mind the fact that some of the most agreeable lights in life, like those in a cathedral, come through a colored medium. In a single word, then, I bid you welcome to a sojourn which cannot fail to be profitable alike to humanity and to fish.

The PRESIDENT: Gentlemen of the Society, we first have to consider the routine business of the meeting, which will come up in its regular order. Has the Secretary any suggestions to offer?

The RECORDING SECRETARY: The first thing in the regular order of business is the appointment of Committees, etc. We have thought that our Constitution needs revision, and I would move that a Committee be appointed to revise it, and to prepare By-laws.

The PRESIDENT: Gentlemen, you hear the motion of your Secretary, that a Committee be appointed to revise the Constitution of this Society, and prepare By-laws. What is your pleasure?

No opposition being offered, it was made a vote.

The PRESIDENT: Of how many shall it consist?

MR. GOODE: I move that the Chair appoint a Committee of three to revise the Constitution and prepare By-laws.

This was voted upon and passed.

The PRESIDENT: The Chair will appoint Mr. Fred Mather, Mr. W. V. Cox and Mr. F. N. Clark.

One of the regular Committees to be appointed is that on nominations to report at the meeting to-morrow morning. That Committee is generally composed of five members.

MR. GOODE: I move that the Chair appoint the Committee on Nominations.

This was voted upon and passed.

The PRESIDENT: The Chair will appoint Mr. G. Brown Goode, Mr. W. L. May, Mr. T. B. Ferguson, Mr. E. G. Blackford and Dr. Tarleton H. Bean.

During the meeting the following were proposed and elected to membership: Hon. Geo. M. Robeson, of New Jersey; Dr. E. W. Humphries, Commissioner of Maryland; W. W. Ladd, Jr., New York City; Frederic R. Ryer, New York City; Prof. H. J. Rice, New York City; Prof. Chas. V. Riley, Agricultural Department, Washington; S. H. Kauffman, *Evening Star*, Washington; W. A. Butler, Jr., Michigan Commissioner; John A. Loring, Boston; Gwynne Harris, Inspector of Marine Products, Washington; S. C. Brown, Register National Museum; J. P. Wilson; W. E. Bailey, Engineer; Geo. H. H. Moore, Newton Simmonds, W. F. Page, J. F. Ellis, J. J. O'Connor, J. E. Brown, A. Howard Clark, W. W. J. Murphy, Thomas Lee and Peter Parker, Jr., all of the U. S. Fish Commission; Ed. H. Bryan and Henry W. Spofford, both of the Smithsonian Institution; Major G. I. Lydecker, U. S. Engineers, and Lieut. Pietmyer, U. S. N., commanding Steamer Fish-hawk.

On motion of Prof. G. Brown Goode, Hon. Spencer Walpole, Governor of the Isle of Man, was made a corresponding member.

The report of the Treasurer was read and accepted, and the meeting adjourned until 2 P. M.

AFTERNOON SESSION.

On assembling, the following was read:

THE GIANT CLAIMS OF PUGET SOUND.

BY ROBT. E. C. STEARNS.

DR. STEARNS, referring to the fact that his paper was the first on the programme, said: At the time my friend Prof. Goode asked me to say something to you about the big clams of the west coast, I supposed that my place would be toward the close of the feast, somewhere near the nuts and raisins, or the special delicacies and dainties of the dessert. However as this is a fish convention, and the Professor's request may be considered as semi-of-fish-ial, I accept the place assigned me, and you must regard what I have to say as being in the nature of grace before meat.

When an illustrious stranger from a remote country visits a great civilized center, it is customary to introduce him into the distinguished society of the place with some formality, if not ostentation. Gentlemen, permit me to make you acquainted with *Glycimeris generosa*, the boss clam of North America, recently from Puget Sound.

You will see that he is in that condition which prevents him from saluting you. Beside, he is by nature somewhat reticent. He is evidently in high spirits (95 per cent. alcohol), but nevertheless speechless (as an Irishman might say), "as many a gentleman has been before."

This clam, *Glycimeris generosa**, by far the largest found on either coast of North America, was first described by Dr. Augustus A. Gould from specimens (probably of the shells only) obtained by the exploring expedition commanded by Commodore Charles Wilkes, during his famous cruise in the years 1838 to 1842, inclusive.

It was detected in Puget Sound and subsequently collected in Awatska Bay, Kamschatka, by the North Pacific Exploring Expedition, under command of Commanders Ringgold and Rodgers; the late Dr. Willam Stimpson was the naturalist of the latter expedition.

The range of distribution, it will be noticed, is quite extensive as from the above points in the North Pacific it extends southerly along the west coast of America to San Diego, California, where it has been found by Mr. Hemphill. A range northerly and southerly twenty degrees of latitude. It is apparently much more abundant in the north than in the south, for Mr. Hemphill states that in the southern locality I have named, in the course of several years he had not been able to find more than a dozen.

From Capt. J. S. Lawson, of the U. S. Coast Survey, I learned some years ago of its frequent occurrence in Budd's Inlet, Washington Territory; from others residing in the same general neighborhood I had heard of its presence at various points in Puget Sound.

Aside from its large size, which would naturally attract attention, its excellence as an article of food is attested by all who have eaten it, and it holds by common consent a place in the front rank, in the opinion of the epicures of the northwest coast.

In the spring of 1882, Professor Baird, being desirous of obtaining further and more definite information as to the occurrence, habits, quality and abundance, etc., of *Glycimeris* or geoduck, † as it is called by the Indians, and also more special knowledge of the principle (so-called) clams of the region, I

*Etymology—*Glycimeris* from *glukous*, sweet, *meris*, bitter *generosa*, from its ample size, etc. Sometimes placed in the genus *Panopæa*, from *Panope* a nereid, ancient mythology.

†Accent the second syllable and pronounce hurriedly, with a hard g and a short o, as if spelled ge-wo'; gewo'duck.

went up to the sound at his request in June of said year, and fixed upon Olympia, at the head of Budd's Inlet, as a base. The character of the sea-bed here may be described as varying from sandy mud to muddy sand, occasionally gravelly, and there is sometimes found a patch of hardened or compactly indurated clay of a light blue color.

The most striking peculiarity of the environment, and the principal one relating to the presence and obtaining of geoduck, is the extreme tides which occur here from about the middle of May to the Summer solstice in June, or a little later, during which period the rise and fall of the tides, or in other words, the difference between high and low water, is twenty to twenty-five feet. Now it must be borne in mind that it is only during the season of these extraordinary tides that the big clam can be obtained. I found that by the 23rd of June, "the long run-outs," as they are called by the people there, had nearly ceased. The white men and Indians employed by me, who had been sent out in various directions, returning at night or early in the morning for three consecutive days had met with "fisherman's luck." I was not disappointed for I knew the cause, not having been able myself to reach the low water line of three or four days before.

By this we are able to perceive more clearly the force of the common expression, "as happy as a clam at high water."

It is presumable that the scarcity of the geoducks along the ocean coast as far to the south as the species are found, is more apparent than real. The rise and fall of the tides along the main coast is, say about six feet, and not sufficient to uncover that portion of the zone preferred by the geoducks; again the temperature of the water at the southerly stations may be too high and cause them to seek a cooler temperature by living at greater depths. As to the more special habits of the geoduck, such as burrowing, etc., the following is not without interest.

Captain Lawson informed me that upon one occasion he saw the end of the large siphon tube projecting above the surface of a small shoal. Upon examining the spot it was found to be sandstone; in order to capture the clam the stone had to be broken with a crowbar. Beneath this superstratum was found sand

and gravel, in which the huge mollusk was "at home." Its communication with the water above being by means of a hole in and through the sandstone capping—through this hole it extended and protruded its siphons. The hole, no doubt, was originally made by the clam, when quite small, in its younger stages, in order to reach a permanent and suitable burrow or bed, and of course the principal growth was attained after it had reached the more favorable substratum of easier material; the hole or perforation through the sandstone being enlarged, coincident with its growth, as needed to meet its requirements.

As may be supposed it is quite a job to remove a good-sized geoduck from its native bed without injury; to do so with proper care as many as three persons are needed, otherwise the clam will be more or less mutilated. The length of the siphons when extended indicates the depth of the burrow, if his word may be used, and an excavation equal to the size of a flour barrel has been made. The instance related of Capt. Lawson's specimen shows the difficulties which are sometimes met with in collecting these big fellows.

This mollusk may well be called *generosa*, for its ample and generous size makes it at least the mammoth clam of North America. According to the testimony of Captain Lawson it has been known to reach the weight of sixteen pounds and frequently seven to ten pounds, while the siphon tube may measure one and a half to two feet in length. Those collected and observed by me weighed from three and a half to seven and a half pounds.

More might be said of the many virtues, which in connection with high water, may be the cause of the clam's happiness, such as pertain to its gastronomic excellencies, etc. Geoduck is however, a real delicacy, and skillfully cooked, would completely puzzle anybody tasting it for the first time, as to whether he was eating fish, flesh or fowl.

The nearest guess that I have heard was by a person to whom I gave a piece, "That it tasted a little perhaps like nicely stewed crab," which hits the mark very nearly. The proper way to cook geoduck, or one way, is to parboil thoroughly, then remove the skin and cut in strips about one inch and a half wide by a half an inch thick (no thicker) and fry the pieces in good batter,

in very hot salt pork fat. I dare to say that parboiled, then stuffed and baked or roasted, geoduck would prove satisfactory to the daintiest epicure. Mr. Hemphill thinks it tastes somewhat like poached egg, but the taste to me did not suggest that of eggs cooked in any form. If fresh and well cooked it is, as I wrote to Professor Baird in my report, "suitable food for good men of scientific proclivities." *Washington, D. C.*

HIBERNATION OF THE BLACK BASS.

BY DR. JAMES A. HENSHALL.

That both species of black bass (*Micropterus*) hibernate in the northerly part of the country, is a fact too well known to admit of a doubt. But, notwithstanding the evidence heretofore adduced in support of this fact, the occasional catching of a black bass during the winter season, in the North and West, is sometimes heralded by correspondents of the angling papers as a proof that former observers have been mistaken, and that these fishes, or at least the large-mouthed species, do not hibernate. Perhaps the term hibernation is not well understood by these writers, which may account for their hasty and erroneous conclusions.

Hibernation does not necessarily imply, as supposed by some, a state of complete torpidity or profound sleep during the entire winter. To hibernate, according to Webster, is "To pass the season of winter in close quarters, or in seclusion," and that is just what the black bass of both species do in northern and western waters, every one who has given the subject any intelligent investigation is prepared to admit.

Hibernation of animals is influenced, doubtless, by conditions of temperature and food supply, and the duration, extent or degree of this period of repose or seclusion, is augmented or

diminished by the particular state of these conditions. In the opinion of the writer, hibernation of animals is influenced as much (if not more) by the supply of food as by the state of the temperature. This is proven by the fact that while the black bass hibernates, other fishes in the same waters are active during the entire winter; and this fact may be accounted for by a lack of the principal food of the hibernating species, and an abundance of the particular food of the non-hibernating species, for it is not likely that the temperature, *per se*, would affect one species more than another. To illustrate: The principal food of young black bass (say from six months to a year old) consists of insects, and of adult bass, of crawfish and other crustacea, and both of these classes of food are very scarce during the winter months in the North and West. On the other hand, pike, pickerel, pike-perch and other exclusively piscivorous fishes find an abundance of certain species, as minnows, yellow perch, etc.

To be sure the black bass feeds on minnows and yellow perch occasionally, but not to any great extent, nor for choice; its weak brush-like teeth are not so well adapted for a fish diet as the canine-teethed fishes above mentioned. And this is one of the strongest arguments in support of the fact of their hibernation, for were the black bass as piscivorous as many would have us believe, there would be no necessity for their winter seclusions on account of a lack of this kind of food. Of the two species of black bass the large-mouthed bass feeds more upon minnows than the small-mouthed bass, and hence is taken oftener during the winter. In the extreme Southern States the supply of crawfish and insects is constant, consequently the black bass does not hibernate in that region. Among the hibernating mammals the black bear, in the extreme South does not undergo the winter sleep of his Northern brethren because he finds his food abundant at that season. And even in the North, during mild winters when food can be procured, the black bear has been known to depart from his usual habit, and has been killed when roaming abroad, when he should have been asleep in his winter den; but such rare exceptions merely prove the

rule, and do not disprove the fact that the black bear is a hibernating animal.

In Europe, the German carp are typical hibernating fishes, burying themselves in the mud at the beginning of winter, their heads together in circles and their tails out, which are kept in motion more or less constantly. But American fish-culturists state that while the imported carp hibernate profoundly, their descendants, on the contrary, are more active during the winter, and the disposition to hibernate grows less with succeeding generations. This I believe to be more on account of an abundant supply of food than upon the temperature, for most carp culturists are liberal feeders, from the fact that carp will grow more rapidly than other fishes if well fed.

German authorities are of the opinion that the carp takes no food during the period of its hibernation (from four to six months), though it has been proved that it does not diminish in weight during this entire time. I do not believe it possible for an animal to abstain entirely from food and maintain a uniform weight for a period of several months, even though it sleep ever so profoundly. (The black bear goes into winter quarters excessively fat, but comes out in the spring weak and emaciated.) I am of the opinion that the German carp derives its nourishment during hibernation from the mud in which it is buried, for it is well known that all of the *Cyprinidæ*, *Catostomidæ*, etc., feed more or less upon the mud of the bottom, or at least upon minute organisms contained therein. This view seems plausible in connection with the fact that in Europe, carp kept in tanks for sale during winter rapidly lose in weight unless fed generously. In American waters, though frozen over during the entire winter, there are always some form of vegetation, larvæ and animalculæ, to be had by herdivorous and bottom-feeding fishes, as carp, minnows, suckers, sturgeon, etc., consequently these fishes are more or less active during the coldest weather, and some of them in turn furnish food for the piscivorous tribes during the same season.

The writer has elsewhere stated: "During a residence of ten years in Wisconsin, where fishing through the ice is constantly practiced during the winter, and where tons of pickerel, pike-

perch and yellow perch were so taken in a single season, I never knew of a single black bass being so taken except very late in the winter or in early spring, say in March, just before the breaking up of the ice; and even in those instances were of rare occurrence, and happened only during unusually mild weather; and these same waters, be it remembered, afforded the finest black bass fishing during the summer and fall."

The above applies to the usual fishing grounds of the lakes and streams of Wisconsin with the water at moderate depth, from four to twelve feet, which are frequented by the black bass, large-mouth and small-mouth, in common with the non-hibernating species in spring, summer and fall, but only by the latter in winter, the bass retiring to greater depths at the begining of winter and remaining until spring, and where they can be taken by the initiated with the right kind of bait; but as I deem such information of no special advantage, except to the poacher and law-breaker, I think it best and proper, for obvious reasons to withhold it. From personal observation I am pretty familiar with the habits of both species of black bass at all seasons of the year, in all of the States east of the Mississippi (except the New England States, New Jersey and Delaware), and with the exception of the Gulf States, I am convinced that both species of black bass hibernate in a greater or less degree, according to the supply of food in the winter season, or in other words, according to the climate. In these exceptional States, during the hottest weather, they retire to the deepest and coolest water to be found, and undergo a condition of rest and seclusion (æstivation) analagous to hibernation; perhaps an inherited instinct.

In the foregoing hastily-written paper I have endeavored to show: (1) That hibernation of fishes (and other animals) is influenced more by the supply of food than by the temperatures for it is well authenticated that fishes can endure extremes of temperature that would prove fatal to other vertebrates. (They have revived after being frozen in ice, and on the other hand, they live in apparent comfort in the water of hot springs of a temperature of above 100 degrees Fahr.) (2) That both species of black bass hibernate in the northern sections of America.—*Cynthiana, Ky.*

Mr. Goode—Mr. President, I should like to say a word or two on this question of hibernation. It seems to me that hibernation is by no means a voluntary act, as might possibly be inferred from some things which Dr. Henshall has said. It is purely a matter of physicial cause and effect, and the question whether the black bass will hibernate in a given latitude depends on the depth of water and the presence of warm spots at great depths in that particular body of water. Every fish has, I think, a certain limit to its powers of activity, a certain limit which varies with different species according to a scale of temperature. Many of the southern fishes which come to our northern coast in summer, are in the fall seen in the cold tidal bays partially torpid. In such a state they cannot feed. It is the torpidity which prevents their feeding rather than the lack of food; and it seems to me that in almost every case the fish has no power to escape from that degree of cold which produces torpidity. From reliable testimony I learn that black bass are taken under the ice in some of the northern lakes, and have no doubt, that in other lakes not so deep, the fish become torpid before the ice forms on account of the shallowness of the water. I think, therefore, that Dr. Henshall's theory is somewhat exaggerated. He may have heard of fish feeding during the period of hibernation. I am not, however, inclined to believe that they ever do this. I certainly very much question the possibility of carp feeding during the period of hibernation. It is generally known that they are then buried in the mud at the bottom of the water. This is a very interesting question, and one whose solution involves a great deal of experimenting. I should, however, hardly like to see the question settled upon hypothetical grounds before such experiments are made.

Mr. Mather—This question of the hibernation of fishes is one concerning which I have no special knowledge. I have, however, paid some little attention to it, having been recently engaged in endeavoring to learn the geographical range in which the black bass hibernates. As touching the question of temperature and food, I know that on our New York coast, in Long Island Sound, there are some fishes which are active all

winter, and others which bury themselves in the mud. The tautog, or blackfish, practically hibernates. I do not think it takes a particle of food during the winter. Flounders go into the mud and so does the eel, which latter buries all excepting its head. All the eels that are taken there in the winter are speared, the fishermen sounding in the mud with their spears. In the middle of April they come out and are taken in eel pots. The tom-cod and some other fishes are active all winter. It always seemed to me that some fishes might be more susceptible to the influences of temperature than others. In lakes north of the fortieth parallel we know that the black bass does not feed much during the winter. Occasionally a specimen is taken with hook and line. Dr. Henshall's theory concerning hibernation is certainly a new one to me, viz: that the question is one of food and not of temperature, and is one, I think, which will bear considerable examination before it be accepted as the correct solution.

PROTECTING AND HATCHING THE SMELT.

BY FRED MATHER.

I will preface this paper, gentlemen, by saying that my paper contains some statements which are so at variance with all my former experiences that I almost hesitate to read what I have written.

The smelt, *Osmerus mordax* (Mitch.) Gill, is not common on Long Island, and but few streams contain it. In the spring of 1884, I attempted to get eggs from a stream at Locust Valley, on the north side of the island, in Queens county. The fish run up the streams at night to spawn, and on this one I spent one night. There were about twenty men with lights at different points within half a mile using what they called "grab-alls" or "snatchers." These were variously shaped contrivances, some round, some square, and others triangular, but averaging about

five inches square, made of wire with frequent cross wires, to which were soldered fish-hooks. Imagine a small grill made by bending a wire so as to form a square, each side of which is six inches, with five interior wires one inch apart, soldered across it parallel to the handle, and on each of these wires, both interior ones and of the frame, are soldered fish-hooks one inch apart, forty-nine hooks in all, and you have one of the most merciless fishing implements that devilish ingenuity has devised. This is the "grab-all," and I have seen many a poor smelt impaled on it when seeking a place to deposit its precious burden of eggs, under cover of the night. I tried to buy one of these murderous implements to exhibit at the London Fisheries Exposition, but failed because the owners had use for them the night which I spent in their company. The men who used these implements were, to judge from their own lips, the most depraved wretches that I ever met. I never fell into worse company as far as language goes.

At Locust Valley there was a scarcity of ripe fish and an absence of milt on the night referred to, and I arranged with Mr. John Cashow, Supervisor of the town, to have one of his men save me some fish taken in nets. The man did so, and picked out, as he told me, "all the nice large ones," which of course were females, for the female smelt is many times larger than her mate. In addition to this judicious selection, he left the fish, some two hundred in number, in a can under the horse-shed all night without attention, and "the nice large ones" were dead in the morning. The season was getting late, and I sent my foreman, Mr. Walters, over there with a fyke-net; but he was threatened with death in several abhorrent forms by the men who handled the gentle "grab-all" if he persisted in taking a smelt in a fyke. He bought half a dozen fish and we tried to take and hatch the eggs, but failed. Milt was scarce and the eggs were not of the best.

The catch has been gradually decreasing for the past few years, not only at Locust Valley, but on all Long Island streams, a result which may be attributed to over fishing, and in my opinion there is need of legislation to protect this valuable little food fish. Their habit of ascending streams at

night and returning to salt water before day renders them liable to capture both ways, and is a habit that, so far as my knowledge extends, is shared by no other anadromous fish, and is not mentioned in any work that I have seen. The fish is well worth protection, for it is a favorite winter fish about New York. It will live in fresh water, and is said to have bred for some years in in the lakes of Vermont, where it is reported that its edible qualities are generally unknown, and it is only used as a bait fish. The fish is found in fresh water in New Hampshire and in Sweden, also in Lake Champlain, but whether it remains in the lake all year or not I cannot say. If they do not remain there the fish go higher up in this case than in any that I know of. On the coasts of New York and New Jersey, twenty miles is about the limit of their ascent.

The first report of the Fish Commissioners of Maine, 1867, under a heading of "Fresh Water Smelt," page 25, says: "Smelts are scattered all over the State. It seems probable that we have more than one species. Whether either of them is identical with the salt water smelt we cannot say, but the resemblance is very close. In several localities they attain a large size. Those of Harrison are said to exceed half a pound in weight, and those of Belgrade to measure fourteen inches in length." In the second report of the Maine Commission they they say, page 29: "It is said that at the mouth of a small stream, somewhere above Bay Bridge (on the Androscoggin), where smelts are accustomed to run in the spring to spawn, and where it has been the custom to dip for them, for several years a seine has been used, and tons of them were taken out when nearly worthless for food. Many were shipped to New York and commanded a price that hardly paid for transportation. This is an abuse which should be stopped. We think no smelts should be taken during the spawning season—say from April 1st to June 1st. Enough can be taken in the fall and winter, when they are in good condition, and it is wonderful that they can stand the draft that is then made on their numbers." In their third report, 1869, the Commissioners say: "The impression has been quite general that the smelt fishery is overdone, and unless some radical measures are taken, it will soon fall into as great

decay as have the salmon and alewife fisheries." * * * * * The act "to protect smelts in the waters of the Kennebec and Androscoggin rivers, approved March 4th, 1869, aims to lessen the catch by prohibiting the use of any implement but hook and line every alternate year, and at the same time allow the fish to ascend those rivers to the points where they were wont to be taken by hook and line. Undoubtedly, the first mentioned object would be attained, but whether the latter would is uncertain. It is desirable to substitute for this some act of wider application, and consequently bearing more equally on all who are engaged in this fishery. I suggest whether a prohibition to take smelts except during December, January and February, by any other mode than hook and line, and perhaps dip-net, would not apply well to the whole State."

Under the laws of Maine for 1874, chap. 248, sec. 58, it was forbidden to fish for smelts in any other way than by hook and line or dip-net, between April 1st and October 1st. The State of Massachusetts passed a law, approved April 9th, 1874, forbidding the offering for sale or having in possession any smelts between March 15th and June 1st, and forbade their capture by any other means than hook and line at any time except in the counties of Bristol, Barnstable and Dukes. I am not aware that any smelts are taken with a hook and line within the waters of New York, nor do I know that there is any law protecting them at any season. The numbers caught are quite small, the market supply coming mainly from the Eastern States, yet in view of the fact that the fish were formerly plenty on Long Island and have been gradually decreasing by reason of continued capture at the spawning season, I believe that it would be to the interest of the people and of the fishermen to protect them from February 20th to March 20th.

In this connection I will read an article written for *Forest and Stream*, headed "Torching for Smelts," by a gentleman from North Bridgeton, Me., in which he describes how smelts are murdered there; he says:

"On the 21st of April the word went round that the "big smelts" had put in an appearance in the streams the evening before. This was enough to bring over a dozen men and boys

to the banks of a certain well-known brook near the head of Long Pond. A part of these carried dip nets, and the most of the others bundles of pitch-wood or jacks, although two or three, one of whom was the writer, carried no equipments of any kind, but went 'merely to see the fun.'

"The evening was warm and very still, and a moon nearly at first quarter helped to prolong the lingering twilight. A fire had been kindled at some little distance from the stream, and as it had been agreed upon to keep away from the water until it was fully dark, all hands were grouped around the fire and were indulging in the usual gossip and jokes of such occasions. All at once some one asked, 'Where's Amasa?' A glance through the intervening alder thicket brought the answer, for in that direction a figure could be dimly seen standing in the brook and busily plying a long-handled dip net. This was sufficient to send everybody to the water, and jacks were soon flaring at intervals along the banks and showing fish by thousands. And now began the excitement. Those who had nets worked them, and those who came "just to see the fun" forgot that this was their object, and waded into the ice cold water, catching the fish in their hands and throwing them ashore. Boys screamed and men shouted. The air as well as water was full of fish, and the sedate man, regardless of shoes and stockings, was knee-deep in the current, his hands grasping here and there, while the pockets of his overcoat and the crown of his hat were full of wriggling fishes. Two dozen fish averaging nearly eleven inches in length, were captured with a single sweep of a dip net. The piles upon the bank were fast increasing to proportions far beyond a market stall, when a rational thought seemed to strike some of the cooler heads. 'Let's stop this, boys; it's nothing short of murder, for we have all we can make any use of.' For once men were reasonable, and boys, as usual, followed in their lead. The fish upon the bank were gathered up, and Rodger's Brook with its swarming waters was left to itself. But in a very short time over three hundred weight of a species of fish that can hardly be surpassed in table qualities were on their way to the village. The express the next morning showed plainly that distant friends had not been forgotten, while a large box placed in front of a store with a 'help yourself' attached was speedily relieved of its contents.'

"But this was only the work of one evening, and the next night the fish would be even more abundant. The word had spread, and long before dark everything for miles around that could be called a dip net was on its way. In place of a net one fellow carried a large corn popper with an extension lashed to

its handle, and another had a tin pan with its bottom punched full of holes and nailed to a pole. Quaint as these implements were, both, it is said, did good service. Through the evening and well into the night dozens of jacks and torches sent their brilliant glare along the stream and into the surrounding forest. No doubt the excessive light frightened the fish and kept many back in the lake, but still hardly an individual went away without fish enough for any reasonable demand. On either this or the preceeding night two men, one to carry a light and the other to handle the net, could have filled an ox cart. This last statement, of course, is on the supposition that the two men could have had the stream all to themselves. As it was, the large number of fishermen, especially on the second evening, rapidly scattered the fish and drove the most of them back into the deep water of the lake.

"The above is only a partial account of what happened on a single stream, and we hear similar reports from nearly every tributary of the Sebago waters. At Bear Brook, in Harrison, but little more than a mile away, the run has been longer and probably even more fish have been taken.

"It would be a work for the scientists to fully explain the different varieties of smelts and their habits. That they belong to the salmon family all agree, but in this particular locality there are three different varieties, commonly called the big, salt-water, and little smelts. The salt-water smelts, *Osmerus viridescens*, are common in all the rivers, creeks and streams along our coast. They are said to bear transferring well, even into waters entirely land-locked and fresh, but always with a diminution in size. The big smelts are like the salt-water variety in some respects, but are larger and darker colored. They are over ten inches in length, and average nearly a quarter of a pound in weight. Many occur much larger than this, and one was weighed here a few years ago that was caught through the ice with hook and line, and turned the scales at eleven ounces. A few are mentioned even larger, but they are rare, to say the least. The little smelts are but miniature representations of their larger relations, weighing less than half an ounce each. Some have thought that these little fellows were only the young of the larger variety, but this can hardly be true, as they seem to be fully developed and are ready to spawn as they descend the streams to their breeding grounds. They do not run up the streams until about a week later than the larger ones, and are much more abundant. They are also found in many localities where the big smelts do not occur. They vary somewhat in size in different places, and are said to be larger in Norway Lake,

only twelve miles away, than they are here. In the last mentioned lake no big smelts are found. An idea of the abundance of these little smelts may be had from the fact that a few evenings since three fellows dipped a shorts sack full (about three bushels) in less than an hour. That this party of wholesale fish killers were under the influence of something stronger than brook water was proved by what followed, for tying up the mouth of the sack, they threw it into the stream and allowed it to drift with its contents out into the lake.

"No person pretends to know anything about when these waters were stocked with smelts, but in all probability they were here long before the country was settled. Although they have been ruthlessly wasted year after year, their numbers have been larger this season than at any time previous. With the exception of the ten or twelve days that they are spawning in the spring, no smelts are ever seen in the streams here. They are caught some through the ice in winter and in very deep water almost always. Those caught through the ice, or with hook and line at any time, are generally larger than those taken in the streams in breeding time. On the whole, smelts in these parts are something of a puzzle, and the people who see the most of them simply expect them to put in an appearance at about such a time, kill them by the thousands when they do come, and think no more about them until their next appearance."

A year passed after the first attempt to get eggs, and late in February, 1885, while looking through Fulton Market, New York, Mr. Blackford told me that smelts were coming in from the southside of Long Island. I sent Mr. Walters down to Brookhaven, a place on the eastern end of the Great South Bay, where the Carman's River or as formerly called, the Connecticut River, comes in. I will here digress to say that the Shinnecock Indians are reported to have had a tradition that this river was a continuation of the great river of that name, which, by means of some subterranean passage under Long Island Sound, breaks out again on the island. The Connecticut River of Long Island is about five miles long, and the smelts often run up it in great quantities, but are said not to go further than half a mile from its mouth. They begin to run in about the 15th of February, and the run lasts one month. They are taken with seines and gill-nets, and an average catch for one man is seventy-five per night.

On the 4th of March, Mr. Walters returned with one hundred and twenty fish nearly ripe and a fair proportion of each sex. Eight had died on the journey from being caught in gill-nets when so nearly ripe, five more died shortly after, and all were more or less injured. From one of the five dead fish I took 30,000 eggs after the fish had been dead fifteen minutes, using a live male. The eggs were taken on a bunch of coarse meadow-grass and suspended in a glass tank with a flow of water from a ⅛-inch cock, and in three days many were dead, and all died at a week old. On the 5th, I repeated the experiment with a dying female. In five day three dead eggs showed, the sixth day 100 dead, seventh day one-fourth of the lot were dead. Up to the 17th, the thirteenth day after taking, there was little change, and on the 20th the eggs were put in a box outside the hatchery in swift water, as they began to show fungus. March 26th, about one-half were alive, and these were in bunches covered by dead eggs and fungus. All the outside eggs were dead, and I had little hopes of saving any. On April 3rd the fish could be plainly seen in the lower eggs by removing the coating of dead eggs and fungus which had covered them for two weeks. The eggs were again placed in the aquarium and 2,000 hatched on April 11th, and on the 16th, 9,000 more hatched and the rest were bad. About one-third of the eggs hatched under conditions which seemed hopeless, and under which it would be impossible to hatch the egg of a salmon or a trout. When the last ones hatched, the mass of dead eggs was rotten and foul. The temperature ranged from 40 to 42 degrees Fahr. In taking the eggs the grass was laid in a milk pan and covered with water. The female was manipulated first, and as the eggs do not stick fast untill some minutes after being taken, perhaps after impregnation takes place, they were distributed evenly over the grass with the tail of a fish.

Knowing nothing of smelt hatching, the literature of which is meager, we determined to try several plans. On March 5th, Mr. Walters took about 50,000 eggs from a weak female on stones the size of a man's fist, in water, and placed them outside the building in a covered waste trough which takes the water from the house to the ponds. The current was slow but the eggs

washed off, refusing to stick in bunches, as on grass. The consequence was that the stones were covered with eggs only one layer deep. Three days after this they looked well, but in a week were all dead, though no fungus had formed. He tried again on March 8th, by taking about 70,000 eggs by the dry method on tiles, letting them stand five minutes before adding water, and then placed them in one of the hatching troughs. On the 16th one-half were dead, and on the 24th they were covered with fungus. On April 7th there had been no change, the eggs underneath the fungus were bright and good, but he went away the next day and did not return until the 12th, when he found the trough empty. The other attendants pronounced them dead and threw them away. Neither of us saw them on the last day, and we do not feel certain that they were dead, for our experience this year tells us that it requires an expert to judge of this. A mass of smelt eggs all rotten on the outside and covered with fungus half an inch long, should be given the benefit of all doubts, and be carefully examined before condemnation.

On March 9th, we obtained 100 more fish which had been taken in seines. The first lot were so badly injured by gill-nets that they were covered with fungus in a few days. On the 12th we got 70,000 eggs on tiles and stones, taken in water, and placed them in a trough which receives the flow from nine hatching troughs, and is consequently carrying a swift current. These eggs were evenly distributed over the tiles and stones several deep, and did not flow off as in previous cases. Not until March 22nd, eleven days after, did we see any dead eggs or fungus. At five days old we could see the formation of the embryo with a microscope, and at fifteen days the fish could be seen with the unassisted eye. At this time fungus had spread all over the outside eggs, but underneath there were but few dead ones. On April 6th, when the eggs were twenty-six days old, they were placed in the glass tanks with a flow from above, and a siphon outlet, and four days later began hatching fast, and two days after we had 11,000 fish, all that we obtained, the temperature varying from 37 to 58 degrees, and the time thirty days. The water in all these experiments was pure spring water.

The last trial was in the McDonald hatching jars and was the

best of all, producing 60,000 fish from 200,000 eggs. They were taken on March 21st by the dry method, let stand five minutes and added half a pint of water and kept in motion twenty minutes by tipping the pan from side to side and occasionly using the tail of a fish. The object of this was to keep the eggs from sticking together, so that they might be treated as free eggs. After this more water was added and the eggs allowed to rest for twenty minutes. They were then washed twice and placed in a McDonald jar. They were taken at 5:10 P. M., were all loose at 6:30 P. M., and at 7 P. M. next day many were stuck fast to the jar and the tubes. On March 30th those still loose were placed in another jar, and on April 2d a few dead ones were observed, while four days later the eggs grouped together in bunches which increased in size until on April 15th, the bunches were of the size of walnuts and covered with fungus. On the 20th a few hatched and on the 21st all that were good came out. From this lot we got 60,000 fish in thirty days with a temperature varying from forty to sixty-five degrees.

The fish are the most minute of any that I have hatched and it troubled us to keep them. A strainer tube inclosing a siphon such as we use for whitefish, was entirely too large, for the fish passed through it with ease. After trying several things and having the aquarim overflow, and the fish go out into the trout ponds, we devised a spiral wire rolled on a stick of four inches diameter and covered with thin muslin; this kept the fish and allowed a small stream to flow out of the siphon which was inserted. I will here say that the lower end of such siphon should be placed in a jar of water in order that it does not suck dry. The difficulty with siphons as outlets is their tendency to empty faster than the inflow, and in consequence they empty themselves and then decline to start again. Placing their lower end in a fruit jar overcomes this failing; they will suck no lower than the top of the jar holding the lower end. I used this plan in the New York Aquarium in 1876, but do not claim to have originated it. Of the eggs remaining attached to the first jar and its tubes in a single layer, not one hatched—most of the fish came from eggs which were in masses surrounded by fungus. This year's experience upsets that of my eighteen previous years

which taught me that the egg of a fish should be clean and free from fungus. I now except the smelt from the rule and think it impossible that the embryo smelt must be protected from too much oxygen and good water by a coating of decayed eggs and fungus. Perhaps this is what gives the adult fish its peculiar cucumber odor.

On April 17th, we turned out in the hole below the waste flume of the mill pond, near the hatchery, 20,000, and 30,000 in a small spring run in the meadows of Mr. W. E. Jones, opposite the hatchery, while later 50,000 which were ordered by Commissioner Blackford to be sent to Mr. R. W. Howe, Ridgewood, Long Island, escaped into our ponds by the overflow of the tanks. The fish are so minute that muslin strainers were required, and an extra flow of water clogged them and the tanks overflowed, so that all our 100,000 fish will get into the harbor through three channels.

I have said that the literature of smelt hatching is meagre. Mr. George Ricardo, of New Jersey, has had experience with these fish for several years and has hatched some, but has published nothing to guide others. A search of my library, beyond which I have no knowledge of what may have been done, reveals the following:

Bulletin of the United States Fish Commission, Vol. I., p. 428 (1881, Charles W. Harding, King's Lynn, England, writes Prof. Baird for information, wants to know if the English and American smelts are identical and if the eggs are hatched in fresh water, says: "Smelts spawn in this river (Ouse) from April to beginning of June, and I am anxious to know if it is possible to obtain the ova either from the fish direct, or from the spawning ground, and hatch it out in gauze trays or troughs, and whether fresh water will do, or is it necessary to have the water partly salt."

Norris, "American Fish Culture" (1868) p. 200, says that here and in England the smelt has been naturalized in fresh water lakes, "although an interference with their anadromous habits produces generations of smaller and, perhaps less palatable fish." I note the caution with which the careful Norris, whom I am proud to call my old angling friend, and whose book gave

me some hints when I had started in as a novice in fish-culture nearly eighteen years ago, says, "perhaps" the fish are less palatable. The adverb shows that while he did not know it to be so he recognized the fact that no fish which lives in fresh water is as good for the table as if it dwelt in the sea, a thing well known to all who live near salt water, but "Uncle Thad." gives us no hint as to smelt hatching.

Jerome Von Crowninshield Smith, M. D., the most absurd and ignorant writer on fish that I know of, says ("Natural History of the Fish of Massachusetts,") 1833, p. 148: "An attempt has been made to acclimate the smelts in a fresh-water pond, but they have soon degenerated, becoming first emaciated, and disappeared, by degrees, till they probably all died." This is my experience with adult fish, although I have now about thirty male fish alive in fresh water, all the females having died.

Mr. Charles G. Atkins, "Report U. S. Fish Commission," 1879, p. 742, says: "November 6th.—This forenoon early, Mr. Munson found a great run of smelts at the spawning shed (above the dam). He said he could have dipped any number if they had not been so shy and quick. As it was he dipped 150 or 200, which I have preserved. They are mature, showing clearly spawn and milt through their transparent bellies. [These smelts are among the most diminutive of their genus, averaging in length but little more than two inches. They are found in several if not all the Schoodic Lakes. In one of the tributaries of the "Uper Dobsey" Lake (Indian name, *Sysladobsis-sis*) they are wont to spawn late in the month of February." See also a series of questions by Mr. Atkins, "Report U. S. Fish Commission," 1880, p. 44.

The best report on smelt hatching is contained in the report of a Commission of Fisheries of Maryland (Thomas B. Ferguson), 1878, pp. 41–94, by Prof. H. J. Rice. His field of operation was at the City of New Brunswick, about eight miles from the mouth of the Raritan River, N. J. Prof. Rice alludes, p. 44, to experiments of Mr. Atkins with the land-locked smelt which I do not find, but which was "not favorable to the handling of this species of adhesive spawn, and if I [he] mistake not, Mr. Atkin's conclusions were that it would not pay to handle it." Prof. Rice

states that Mr. Atkins hatched some eggs which were exposed to the full force of running water, "in fact, that spawn only hatched which remained attached to grass, twigs, or other articles situated in a direct raceway, and where the water rushed along very furiously. The spawn seemed to require, at least for its artificial culture, a constant and furious change of water, differing, undoubtedly in this respect, very widely from its requirements when deposited by the fish upon its natural spawning grounds. The fish the Commission had to deal with, on the contrary, anadromous, and we had no rush of water in which to deposit the spawn."

Prof. Rice used the Ferguson hatching jar. He records the use of glass, untwisted rope-warp, gauze, etc., and says: "The greater portion of these dead eggs were upon the grass, rope, moss and twigs already mentioned, and the greater portion of fish came from those eggs which were taken on trays covered with gauze, and those eggs which were massed together in the bottom of the jar, in the strength of whatever current there was." He says; p. 52, "This fungus covering the eggs must have a very deleterious effect upon them, and I do not think it would be very wrong to ascribe to it the death of a goodly portion of the eggs."

I read this some years ago and agreed to it because not only my own experience, but that of every other fish-culturist agreed that fungus meant death to all fish eggs. My lessons this winter seem to prove that with the eggs of the smelt a rush of water or rather an excess of oxygen which is brought by it, means death, and the outside eggs meet it first, and by the bulwark of their dead bodies those inside are preserved. I am aware that this is not only a new view to take of the development of a fish egg, but one that is liable to assault from many sides. Still, with only one season's experience, I launch it as my present belief, subject to change as the fugitive *Tempus* discloses new facts or brings forward new experiences. I have never feared to hold unpopular beliefs or to stand by what I thought to be right, and now only wish that the smelt had yielded more eggs, which might have been tried in all degrees of flow, from moderate to almost stagnant water. Certain it is that all the fish we hatched came from eggs protected from rapid changes of water by a

coating of dead eggs and fungus, which, by the time the interior eggs were hatched, was a most foul and filthy mass, really unfit for a visitor to look at, for he would not have believed that a fish could issue from it.

To complete this experience it will be necessary to say that Mr. Ricardo wished to try an experiment in transporting smelt eggs, and one morning brought to Mr. Blackford some twenty thousand eggs, taken on grass, sewed on muslin stretched on a wire frame, and packed in moss. This lot was placed in a hatching trough in swift water the night after receiving, and when removed at about the time of hatching to a glass tank, some twenty fish came out, a result not encouraging to that mode of packing. He afterward sent me eighty thousand fry by express in a ten-gallon can, which was twelve hours on the way without attention, but they arrived dead. It is his belief, and I understand that it is shared by Prof. Rice, that the fry need no change. I am not prepared to accept this view, which if true is singular, for the fish hatch in swift brooks.

—*Cold Spring Harbor, N. Y.*

Mr. Lyman: The results of Mr. Mather's experiments regarding the protection of eggs against the action of water, appear to me somewhat novel. Perhaps some gentleman would like to make some observations, or relate experiments of a kindred nature which he may have conducted.

Mr. H. J. Rice: In regard to the work of Mr. Atkins and myself it may be well to state that just before beginning operations at New Brunswick, a letter was received from Mr. Atkins detailing briefly his method and amount of success in his work in Maine and my work at New Brunswick, followed to a certain extent his experiments, modified very largely, of course, by the different conditions of our more southern locality. Some of his methods for gathering and holding the spawn I found to answer very well, but I misunderstood some of his writing and was under the impression that he had not been successful, but found out afterward in conversation with him, that he had hatched out quite a large number of the eggs with which he was experiment-

ing, and he thought that his experiments, taken as a whole, should be considered as fairly satisfactory. As to my own experiments since 1876 and 1877, the result serves to show greater success in hatching smelt in comparatively stagnant water than in any other manner. The smelt appear to be a peculiar form among fish, and is at present no longer considered as one of the *Salmonidæ*. Young smelt will live in the same water for nine days, and fish-culturists will at once recognize the vast difference in this respect, between these minute embryos and those of some of the *Salmonidæ*, where a constant change of water is absolutely necessary. Again, the warmer the water the better the smelt appear to thrive. If you take the smelt out of this bottle (pointing to a bottle of young smelt on the chairman's table) and put them in cold water, they will die. Place them near the stove and they will become more lively than ever. I do not know the limits of heat and cold which will respectively produce activity or death with these fish; but I do not know that if water containing smelt be cooled to a temperature in which trout would enjoy themselves, the smelt would die. With regard to the effect of fungus upon the fish, I think that, while in some cases it proves fatal to them, yet in others, as Mr. Mather has suggested, it forms a protection for the fish which are inside of the bunch. Last year and also this season experiments have been in progress to ascertain the feasibility of hatching young smelt in comparatively stagnant water. So far this plan appears to be successful. Large numbers have been hatched out and with comparatively little trouble. This corresponds in a great degree with what Mr. Mather has said, and I am inclined to think that eventually we shall find that the less cold water we use, the larger will be the number of eggs hatched out. It may possibly be necessary to kill the fungus by the use of salt mush.

Mr. Lyman: I recollect in 1867 or 1868 trying to hatch some of the large variety called Belgrade smelt. I put them in running water, somewhat swift, in which I kept my trout eggs, but none of them hatched. The smelt is, of course, a very interesting fish, and is one of the first species by which the fact was demonstrated that quantity might be increased by good laws.

As you will all recollect, some twenty years ago or rather more, in Massachusetts the smelt fishery had greatly declined. It was supposed to be due to the capture of the fish by means of nets stretched entirely across the brooks, which prevented the fish from ascending the stream. The law to which Mr. Mather has referred was passed on the recommendation of the Fishery Commissioners of Massachusetts. In two or three years the catch of fish was very greatly improved, so much so, that the bays and streams which had been nearly depopulated, once more became filled with valuable fish. Ever since then, we have had a pretty good supply of smelt in our State. I was very much interested in the reference of Mr. Mather to Dr. J. C. Smith, as being the most ignorant man that had ever written about fish. It illustrates the theory that in order to succeed one should always be profoundly ignorant of the subject. He took up the matter of naming American fishes, and for this purpose he used the Latin names that corresponded to European fishes, which bore the same English names as did American fishes. In this way he often stumbled on the right nomenclature. At that time it was supposed that the same species of fish were not to be found on the two sides of the Atlantic. Since then, however, many of these species have been proved to be identical, so that Dr. Smith was one of the first persons accidentally to recognize a prominent scientific fact which has only been attained by years of hard study.

THE PORPOISE FISHERY OF CAPE HATTERAS.

BY FREDERICK W. TRUE.

There is a legend among the Indians of Brazil that when the shades of evening are falling on the Amazon, the dolphin (called inia) becomes transformed from its peculiar fish-like form, and assumes that of a lovely maiden. Passing through the streets of the village, her fair hair floating on the breeze, the youths are

attracted by her charms and follow her in crowds. When she has walked through all the streets she reaches the banks of the river, dons her fish-like mien, and plunges in suddenly. The youths in hot pursuit, oblivious of their danger, fall down the steep and perish in the water.

Such a transformation as we have indicated, though certainly with some radical modifications, has taken place in the eyes of some capitalists of Philadelphia in regard to one of the porpoises of our own coast. They think they see in this common porpoise not a useless creature, but an animal from which great profit can be derived if proper means are taken to secure it. They have, therefore, undertaken to utilize this animal for industrial purposes. It is not the first time in the history of industries that porpoises have been made use of. Inhabitants of all Arctic countries, as the members of this Society are aware, are accustomed to feed upon porpoises, especially the smaller species, and to utilize especially their flesh and oil. In this country, too, certain species of porpoise have been employed at one time or another in connection with industrial pursuits.

About 1790 there was quite an important fishery for the capture of porpoises on Long Island. This was in operation for several years, but eventually failed to yield a profit. There is now a similar fishery, if such it may be termed, not only on our own coast at Cape Cod, but also on Norwegian shores. The object of capture in this instance, however, is a different species of the family of dolphin—namely, the blackfish. This animal is occasionally stranded on our shores, and usually is seen in herds comprising 400, 500 or 600 individuals. From these cetaceans valuable products are obtained, the most important of which is oil. It is a rather curious fact that many of the most important fisheries are carried on for the capture of animals other than fish. The whale, for whose capture so much energy is devoted, and so large an amount of capital invested, is not a fish. Again, the object of the seal fishery is a mammal: of the oyster fishery a mollusk, as also of the pearl fishery; of the lobster fishery, a crustacean; and it now seems as if we are to see the fishery rise to considerable importance, whose object of capture is not a fish, the common dolphin of our coast. The species, *Tursiops tursio*,

a cast of which I have placed before you, is exceedingly common.

It sports in the waves from Maine to Florida. I have observed them at various points, especially between Cape Cod and North Carolina. They are fearless, approaching very closely in shore, perhaps not further than twenty or thirty paces. They play around the steamers and sailing vessels regardless of any danger.

The specimen before you is not full grown. The species attain nine, ten and even eleven feet in length. They are not very rapid swimmers, but can attain considerable speed. Regarding their habits we really know very little. They appear to breed at all seasons of the year. It was this species and one other which were known to the ancients and entered into their art. They were portrayed with curious conventionalization on their coins, and were endowed with many peculiar attributes which certainly not even man himself possesses, much less the lower animals. The species before us has been known from time immemorial. Its distribution seems to be very wide. It probably occurs in all salt waters of the globe.

The fishery which is now being prosecuted at Cape Hatteras has been carried on in a minor degree for many years. As long as there has been a colony on the coast of North Carolina, the fishermen have been in the habit of catching some porpoise during the winter and converting them into oil. The apparatus used for this purpose was, however, very rude, and consequently the oil produced was of no great value. Last year, however, for some unknown cause, it occurred to certain gentlemen in Philadelphia that this animal could be made more profitable than had before appeared, and they therefore formed a company with their base of operations near to Cape Hatteras, where they were engaged last winter in catching porpoises. So abundant are the dolphins at this point that they had no difficulty in taking 2,000 during the cold weather. The fishing season is not yet finished, and it is probable that 1,000 more will be added to the number captured.

The method of the fishing is the same as has been in use for a long time by the fishermen of Cape Hatteras. Having explained this at length in print, it is perhaps unnecessary to dwell upon the details at this time. I may say, however, that it con-

sists simply in surrounding the animals with large nets, forming a great pond from which they cannot escape, and then sweeping out a few at a time by means of a smaller net. Sometimes 600 are surrounded by the large nets, and of this number fifty or sixty are hauled ashore at a time. They are drowned as they come up, or if still living, are killed with knives.

The products, which the Hatteras Porpoise Fishing Company hope to derive from the capture of these animals, are primarily oil and leather. There is no doubt that, if properly purified, their oil would be of a high grade, and could be used to great advantage in the arts. So far as the leather is concerned, it must be more or less a matter of experiment for the present. Unquestionably certain members of the family *Delphinidæ* furnish excellent leather. We have in the museum some which was made from the skin of the white whale. This is (or until recently was) extensively used in Canada. Excellent leather is also made from the skin of the blackfish, of which I have seen magnificent samples. From the skin of a blackfish a piece of leather of large size can be manufactured. This porpoise leather, though not very thick, is exceedingly tough and entirely waterproof. It has not great market value at present, excepting in a limited trade, but I think this is simply because it has not been put upon the market in any considerable quantities. As soon as people recognize the quality of this leather, and as soon as a sufficient quantity of it is made, so that it may be brought into general use, I think it will become very popular in the manufacture of articles for which a somewhat thin, very tough and entirely waterproof material is required. The Hatteras company, not satisfied to produce oil and leather only as fruits of their labors, hope to render the flesh palatable as food. In this I fear they will not be entirely successful. The flesh of this animal has a strong, oily flavor which does not disappear entirely until quite dry, in which state it would be, I fear, too tough to eat. In Arctic regions, however, the flesh of many such animals is eaten. In Norway, too, the flesh of considerable numbers of blackfish is consumed. It is cut up into small strips and dried in the sun until quite hard. I am not familiar with the process of cooking.

Regarding the value of this porpoise fishery, it may be said to be quite important. It has been calculated that each porpoise as it lies upon the beach is worth $25. If such an estimate be correct, it is not difficult to understand that the conversion of its oil and skin into objects of commercial use would add considerably to this sum. If the company captures 3,000 or 4,000 a year, the first value of the product to the company will, according to the figures, be $100,000. Of course this value would be greatly enhanced when the products were manufactured into objects of use. For a single fishery this is by no means a small sum. The success of this company will probably have an important bearing upon the formation of other similar companies in the future.

I can see no reason why the pursuit of an animal so easy to capture, and from which marketable articles of such undoubtedly high grade can be obtained, should not be profitable to the fishermen. Of course there are certain prejudices to be removed; but if the company shows a fair amount of persistence, I see no reason why their labors should not be crowned with great financial success.—*Washington, D. C.*

Mr. Goode—I should like to say a word or two about the products to be obtained from the porpoise. It seems to me that the possibilities of this fishery are very great, provided that the number of animals caught is sufficient to make it worth while bringing them into the markets. As regards the food value of the porpoise, I would say that I have tasted the Norwegian whale product—a whale hermetically sealed in tin cases at the London Fisheries Exhibition in 1883, and really it had in some way been divested of its oily taste, and resembled beef *a la mode*. It seems possible, therefore, that some method may be found for removing the oily taste from the porpoise flesh. As to the value of the oil it is undoubtedly so far superior to any other animal oil, that I cannot doubt its coming into general use for lubricating purposes, as soon as it can be sold for a reasonable price. At present twenty-five cents is charged for a bottle hardly larger than one's little finger, and I am not aware that any of the oil is put on the market in a cheaper form. The leather made from the skin of the porpoise is held in high

esteem in Europe for walking boots—especially by Alpine travelers. In London a good pair of such boots is worth fifteen to twenty dollars, nor can they be obtained for less. As you are all probably aware, the leather of the white whale was some years ago used by the Canadian government exclusively in the manufacture of mail bags, being indestructible and impervious to water. These qualities render it a most desirable leather for boots. I am also under the impression that this leather is particularly adapted for belting for machinery and for lace leather. Porpoise leather boot laces are in great favor abroad. I might perhaps enlarge upon what I have said in regard to the special applications of the products of this animal, but am satisfied that they are numerous and may be made of great commercial value.

Mr. H. J. Rice—It will perhaps not be out of place for me to say that at the present time porpoise leather is used to a large extent in New Brusnwick and along the coast of the British Provinces from the St. Lawrence down, and is highly esteemed. I have been informed by Commissioner Stillwell, of Maine, that he uses shoes made of this leather in preference to any others, and I understand that they are quite commonly used in St. Johns and other cities of the Provinces.

Mr. Lyman—In regard to the use of porpoise flesh as food, I find that like many other things in this world, it is a matter of taste. One gentleman in Washington has said that he considered smoked porpoise flesh superior to smoked beef, and another said he had eaten mule and consequently could eat porpoise. We all must have noticed, I think, that among civilized nations the favorite articles of food are the result of a passing fashion, certain conditions, as of nutrition and a fairly agreeable taste, being present. I remember that at one time about a dozen cusk would supply the whole of the Boston market, because there were only that number of families that knew it was good to eat. In external appearance the fish is extremely repulsive. At the present day this same fish commands a very large price as a delicacy. Again, in regard to the whiting of this coast, I have known it thrown away by the cartload because it could not be sold in our markets. On the shores of the

Mediterranean, in France, and generally throughout Europe wherever the whiting is found, it occurs in very great numbers, and is one of the highly prized species. Therefore, I believe that, if porpoise flesh can be made to taste like smoked beef, push and perseverance on the part of this company will crown their labors in success. Oleomargerine is unblushingly sold for butter everywhere, and one gentleman, a member of the U. S. Geological Survey, said he preferred it to butter because it would keep better.

[As Mr. True a few weeks later changed his opinion concerning the value of the flesh of the porpoise as food, I take the liberty of inserting the following from *Forest and Stream*, June, 1885.—Recording Secretary.]

PORPOISE STEAK.

Editor Forest and Stream:

We live in an utilarian age. An age in which a man anoints his rheumatic joints with the waste products of petroleum, fills his confectionery with the parings of hoofs and horns, and writes his *billets doux* on the pressed pulp of the rags that blow in the streets. Yet the historian of these times will write us down as an unenterprising and wasteful generation. With what abuse we should have loaded the Indian had he trusted for his subsistence to the animals he could tame and rear, and let the unnumbered herds of buffaloes that darkened the plains in the old days go by his lodge unmolested. We should have looked upon his destruction by our pious ancestors as not the least pious of their deeds. Yet we who esteem ourselves so much above the aborigines allow a vast race of food-supplying creatures to disport themselves before our very eyes and make no effort to utilize them. I mean the cetaceans. But you will say that porpoises are not fit to eat, that their flesh is too tough, coarse and ill-flavored. I have said so, too, and that recently before the American Fisheries Society. But I have been converted, and my conversion was in this wise.

On returning from their last cruise on the Hatteras ground, the naturalists of the Fish Commission's steamer *Albatross* captured and brought in on ice two specimens of the common dolphin (*Delphinus*

delphis), one quite young. When these had been properly examined from a scientific point of view, the proposition was made that the younger one be converted into steaks. A number of pieces were cut from the middle of the back, and in a few moments the most promising of them were broiling in fine style before the fire. When they came upon the table they had the appearance of small tenderloin steaks, such as one may have served up in any well regulated restaurant, and the best bull ever bred could have no spot in him more tender than were these same small steaks. But the flavor! Some one has said that the odor of a rose is not to be described. So with the flavor of this porpoise. If I say I was reminded of liver, you will cry out that it was coarse; if I say there seemed to be something in it akin to juicy duck, you will suspect rankness; while if I affirm that there was a suspicion of delicate fish, your thought will be on blubber. But even as in order to know the delicacy of a rose it is necessary to smell one, so if you would know how the flavor of a porpoise steak can combine harmoniously that of a liver, a canvasback and a king-fish, you must eat one.

There are several morals which might be drawn from this simple and affecting tale, but perhaps the most important are these: (1) Take your steak from a young porpoise and (2) have it properly cooked.

If all young porpoises are as palatable as this dolphin of the ancients, it is a pity that so much succulence should waste itself upon the waves, and never a morsel come to relieve our *menu*. The golden age of gastronomy was long ago, and in that time kings and other great persons looked upon porpoise as a delicacy of delicacies. May we not hope that some day our *menus* may again be enlivened by some such phrase as "*Marsouin au Commissaire des Peches*," or "*Dauphin brasille aux Esquimeaux du pole arctique?*"

WASHINGTON, June 8. F. W. TRUE.

THE PRESIDENT: Under the instructions of the Executive Committee, the secretary has written to the private secretary of the President to ascertain if it will be convenient for the President to receive the members of the Society to-morrow morning. An answer has not yet been received, but the Society will be informed of the result to-morrow morning.

It was then proposed and carried to let the reading of papers be continued until Wednesay morning. The Society then adjourned until 11 A. M. Wednesday.

WEDNESDAY, May 6th, 1885.

The meeting was called to order and the reading of papers continued.

RESULTS OF PLANTING WHITEFISH IN LAKE ERIE.

BY FRANK N. CLARK.

After the close of the fishing season of 1884 in Lake Erie, I began an inquiry to ascertain whether there had been an increase or decrease in the catch of whitefish as compared with that of former seasons. The investigation was conducted by personal interviews, through a representative, a practical fisherman, with the leading fishermen and dealers, and covers most of the important fisheries of that part of the lake from Erie, Pa. westward to Toledo, Ohio. The results are most gratifying, as it is conceded by all and shown by the reports, that the aggregate catch of whitefish was considerably in excess of that of any season for several years. The results are especially encouraging to fish-culturists, as all the facts and statements point to but one conclusion, namely, that the increase is due to the planting of young fish from the hatcheries.

No disappointment would have been felt had there been no perceptible increase, as much was required to offset the extensive and exhausting fishing carried on all over the lake, on both the spawning and feeding grounds, which was causing a gradual decrease of the catch. For many years every spawning ground had been literally covered with nets during the spawning season, while hundreds of gill-nets have been employed on the feeding grounds in deeper water, and thrown across the path of the runs towards the spawning grounds. In no other of the great lakes has the fishing industry been pursued with greater persistence and skill than in Lake Erie. Notwithstanding this, however, we find that not only has the decrease been arrested, but that there is a tangible and satisfactory increase.

The figures given below show in round numbers the aggre-

gate plantings of whitefish fry in Lake Erie, from the beginning of the work by the United States and Ohio and Michigan Fish Commissions. Some plants were also made by the Canadian Commission during the years mentioned, but I am unable to give the figures:

Spring of 1875 -	150,000	Spring of 1879 -	7,000,000
Spring of 1876 -	300,000	Spring of 1880 -	7,000,000
Spring of 1877 -	450,000	Spring of 1881 -	13,000,000
Spring of 1878 -	12,000,000	Spring of 1882 -	42,000,000

These figures include the latest plantings that could possibly be called due in the fall of 1884. Under the current method of computing the numbers of young fish in tanks and cans, there is no doubt that the estimates shown in the above figures are much too large.

Following are a number of statements from fishermen and dealers, in substantially the exact language of the parties making them, with regard to the catch and the value of fish propagation and planting:

L. Streuber, Erie, Pa., says; "Am dealer and shipper of frozen fish, and fish considerable twine. Can give you the figures of my catch for only the past two seasons, which is as follows: Catch of whitefish for 1883, 110 tons; 1884, 150 tons. I believe the propagation of whitefish to be a great help toward keeping up a stock in the lakes; so much so that I am doing all I can to get a hatchery started here, believing it will pay."

C. D. Carter, another dealer and fisherman in the same city, says: "My catch of whitefish for the past two years is as follows: 1883, 175 tons; 1884, 225 tons. I think that the planting of young whitefish in Lake Erie has already done a great good toward keeping up and increasing the stock of whitefish in its waters. I hope to see the hatcheries kept up, and would like to see one here in Erie, believing we have a good location for one, and that it is a good point to plant fish from, as there are no carnivorous fish caught at the season of the year when the young fish would be put in."

John Harlow & Co., of Erie, make the following statement: "For the past five years our annual catch of whitefish has

been about 150 tons, until 1884, when it was 200 tons. The increase of fifty tons I attribute to the planting of young whitefish from the hatcheries. I am very much in favor of the planting, and hope it will be kept up, as I am satisfied that it is of great benefit to the fishing interest of the lake. A few seasons since we commenced catching very small whitefish—so small that we had to get smaller-meshed nets, and now we are getting a larger class of fish again."

H. Divel, fish dealer and practical fisherman, also of Erie, says: "I have been fishing for some time, and think the whitefish for the past three years have been increasing. I can give the figures of my catch only for the past two seasons, as follows: 1883, thirty tons; 1884, fifty tons. I think the business of hatching and planting is of great benefit in keeping up the stock; for with the increase of twine, the whitefish must soon be caught off if nothing is done to keep the stock good. There can be no reasonable doubt about the young fish living and becoming full grown. They stand just as good a chance as those hatched naturally, their danger from carnivorous fishes being no greater than those hatched on the reefs."

B. Divel, of Erie, gives similar testimony: "My catch of whitefish has improved for two or three years. The figures for the last two seasons are: 1883, thirty tons; 1884, fifty tons. From the fact that whitefish are steadily increasing in numbers, I believe the hatching and planting of the young is a success, and the cause of the increase."

Charles Joles, of Erie, a gill-net fisherman, says: "I fish gill-nets off Elk Creek. Cannot say how many whitefish I caught in the different years, but know I caught more in 1884 than in any season for several years. I attribute the gain to the planting of young fish at the upper end of the lake. I am satisfied that were it not for this, whitefish would become so scarce that it would not pay to fish for them."

Rudolph Sifield, of North Bass Island, says: "I fish with pound nets and own some gill-nets, but would willingly put the latter in a pile and burn them, if gill-net fishing could be prohibited. Gill-nets are a great detriment to natural propagation,

as they are set on the reefs in spawning time, right where the fish go to breed, and the schools are broken up or driven off entirely, and the eggs are then deposited in the mud and never hatch. Good results may now be seen from fish-planting, but the business has not been carried on long enough, nor on a sufficient scale, to tell what it will do in the long run."

Simon Fox, of North Bass, gives his opinion thus: "Have been in the fishing business for years, and until the past season never believed there would be any results from the planting of young fish. Now I am fully convinced that good results are to be seen, and if it is continued, great results will follow."

Jasper Snide, of North Bass, says: "Our twine caught a few more whitefish in 1884 than in 1883, and I think we should have done still better but for the unfavorable fishing weather, it being so still that the fish remained on the reefs beyond our nets continuously until we got those heavy blows, which drove them off entirely. Formerly I did not have any faith in the planting of young whitefish, but am now sure we can see good results. We now catch a great many of a smaller class of fish, which we never did before the planting was commenced, and if the stock had not been kept up in some other than the natural way, they must have decreased in numbers, and we cannot see that they have in a few years."

George Axtell, of North Bass, states: "Whitefish are increasing in numbers all the time, at least this is true of my own nets, and I feel certain that it is owing to the planting of young fish from the hatcheries. Last fall I caught numbers of small whitefish, such as I never before caught in gill-nets."

William Axtell, practical fisherman, of North Bass, says: "I know that the planting of young whitefish is a great help to the fishing industry. Would like to see more fisheries put up—enough to take care of all the eggs that could be taken."

Eugene McFall, clerk of the steamer *Jay Cooke*, freight and passenger boat plying between the islands and Sandusky, says: "I think there is an increase in the catch of whitefish, and I suppose the planting must account for it. We carried from the islands in 1883 about 132,000 pounds of whitefish, and in 1884, 170,000, an increase of nineteen tons for 1884."

George Winne, of Locust Point, says: I fish gill-nets on the reefs off Toussaint Point. In 1883 I caught two tons of whitefish from sixty nets, and in 1884 six tons from thirty-six nets. A few years ago it got so it did not pay to go out on the reefs to fish, and I quit and went sailing. Since the planting of young whitefish has been carried on, fish have become more numerous, and I have done very well fishing, but best this last fall. Think if the planting is not kept up whitefish will soon become scarce again. Think a much greater percentage of eggs put into hatcheries will live to become mature fish than those deposited on the reefs by the fish themselves, for the reason that the former are protected from their enemies while hatching, and after the young fish are planted their chances are just as good."

M. Shepherd, also of Locust Point, states: "Am fishing fifteen pound-nets off Locust Point. My catch the past season was about as usual—no material difference. Think the hatching business a good thing, but the proper place for a hatchery is on one of the islands; then the eggs would have the natural water, and when the fish are planted there would be no change from the water they were hatched in to that which they are planted in."

Nelson Parsons, a practical fisherman of Vermillion, says: "I have watched the fishing interests very closely for a number of years, and noticed that whitefish are steadily decreasing in numbers, until the supply was replenished by the planting of young fish from the hatcheries. If something of the kind had not been done, I think that whitefish would, ere this, have become so scarce that it would not pay to fish for them. Formerly we used to catch whitefish of all sizes at the same time, but this season at Cleveland, where I was, the fish were nearly all of one size—looked as if they were all of the same age, and I believe they were a school of the planted fish. I think if fishing is continued it must be done in this way."

Edson & Nichols, of Vermillion, caught one ton less of whitefish in 1884 than in 1883, but say: "We do not attribute the falling off to a growing scarcity, but to the direction and amount of wind, which is everything to us here in the fishing

season. We think the hatching business of great importance, and the only way of keeping up the fishing industry."

Bert Parsons, also of Vermillion, caught no more whitefish in his pound-nets off Vermillion in 1884 than in 1883, but caught double the number in his gill-nets near the islands. He says: "I think if there had been favorable winds for pound-net fishing we would have caught more than double the amount of whitefish in our pound-nets last fall. I know the business of planting has been of great benefit, for in my gill-nets fished about the islands I caught double the quantity last fall that I did the year before. The figures are: 1883, five tons; 1884, ten tons."

Leidheiser, of Vermillion, says: "I cannot give the amount of my catch, but it was rather light, owing to the unfavorable winds we had for our coast. I think the hatcheries are all right, and do a great deal toward keeping up the stock, and that the business should be continued and extended beyond where it now is."

Post & Co., of Sandusky, give some excellent testimony: "Yes, sir; I know that the business of propagating whitefish is a great benefit. In fact, if the United States and State hatcheries were to cease working, I believe it would pay the fishermen and dealers to continue it themselves. I would be willing to be taxed my share for supporting it. I understand that at Erie and Dunkirk a great many small whitefish were taken weighing a pound to a pound and a half, which was never done until the last two or three years, and they increase year by year, which is good proof that they are some of the planted fish.

"I received the fish from 100 pound-nets last year (1883) and from 110 this year (1884), with the following results: 1883, fifty tons whitefish; 1884, eighty tons whitefish.

"Whitefish are not now decreasing; but from the number of pound and gill-nets in use to catch them, a decrease is sure to follow unless the artificial hatching is continued to keep up the supply.

"I am opposed to fishing such long strings of pound-nets, and think the gill-netting needs regulating. The gill-netters commence away down below, off Buffalo and Erie, in deep

water, and fish all summer; then, as the fish move up toward the head of the lake to the spawning grounds, the nets are moved right along with the runs, so that they are hunted almost the year round, which is done with no other kind of fish."

Harry Molyneux, of Sandusky, gives some valuable testimony: "Am a practical gill-net fisherman. A few years ago fishing on the island reefs got so poor that I gave up going there; but in the fall of 1882 I tried it again, and did very well. In the fall of 1883 I caught double the amount of whitefish I did the fall before; and this last fall I caught almost twice as many as in 1883.

I credit all the increase to hatching and planting, and would like to see more hatcheries."

William Rehberg, pound-net fisherman, of Middle Bass Island, says: "Think the hatching a good thing, but the planting has not been properly done long enough to tell really how much benefit it is toward keeping up the supply of whitefish. Think the supply could be kept up in Lake Erie by prohibiting gill-net fishing west of Kelly's Island, which would give the fish a chance to breed on the natural spawning reefs, where the gill-nets are now placed."

Caspar Voight, of Sandusky, says: "My catch of whitefish in the past two seasons was as follow: 1883, from thirty-five pound-nets, thirty-seven tons; 1884, from thirty-five pound-nets, forty-five tons.

"I have not thought much about the hatching business, but it must do some good; at least there seems to be an increase in whitefish the past two or three years."

Simon Schact, of Sandusky, says: "My catch for the past two seasons is as follows: 1883, forty-two pound-nets, forty tons whitefish; 1884, forty-eight pound-nets, fifty tons whitefish.

"I believe the planting of fry to be a good thing, and the only way the fishing can be kept up. I fear, however, that the way the gill-netters are catching them, and going on the breeding grounds and disturbing them while spawning, will do more harm than the hatcheries can do good. The fishermen down at Erie and Dunkirk receive the most benefit from the planting, as they

fish with gill-nets all summer, and are using small-meshed nets every season, on purpose to catch the small whitefish."

Lay Brothers, of Sandusky, say: "Our catch of whitefish for the past two seasons was as follows: 1883, from twenty pound-nets, sixteen tons; 1884, from thirty pound-nets, twenty-six tons.

"We think it is plain to see that there is a benefit to be derived from the hatcheries, and would like to see as many in operation as there are eggs to fill."

Dewy & Co., of Toledo, say: "Our catch the past season was rather light. We do not attribute this to a scarcity of whitefish, but to the unfavorable winds that prevailed on our Monroe coast grounds all the fall until a late date; then just as the fish began to come on, we had two severe blows from the west, which drove the fish from the shore, and they did not come back, or, if they did, we did not get them, as our twine was out.

We think the business of planting young fish an excellent thing; we can see no reason why it should not be, as every fish planted in that way is a clear gain. We see no reason why planted fish should not stand as good a chance to live and become grown fish as those that hatch on the reefs."

Wm. St. John & Co., also of Toledo, say: "Our receipts of whitefish for the past two seasons are as follows: 1883, from twenty pound-nets, 6,000 pounds; 1884, from forty-five pound-nets, 18,000 pounds.

"We do not see that fish planting has been of much benefit to this end of the lake, but I am informed that great benefits have been realized further down.

"We would like to see Congress take hold of the matter and enact a law to control and restrict the fishing with gill-nets; also with such long strings of twine. Although we ourselves are fishing twenty and twenty-one pounds in a string, we would like to see them cut down to six at most on main shore, and not more than three off the islands, or any place where there is a narrow channel. Then the whitefish would have a better chance to get through to the coast and reef-spawning grounds at the head of the lake, which they would do if they were not turned back by the long strings of twine."

J. C. & J. H. Davis, of Toledo, says: "Our catch of white-

fish for the past two seasons was as follows: 1883, six tons, and 1884, from the same number of nets, six and one-half tons.

"Do not know that planting of young fish has been of much benefit to us at this end of the lake, but can see no reason why it should not benefit somebody. Certainly, every young fish put in makes one more chance for a whitefish, as the eggs would be lost if not taken."

E. Alvord & Son, of Sandusky, says: "Our receipts of whitefish for the past two seasons were: 1883, from fifty-two pound-nets, twenty-three tons; 1884, from the same number of nets, thirty and one-half tons.

"Yes, we think that propagation is a good thing and a great help in adding to the supply of fish in the lake. We think the young fry stand just as good a chance of becoming full-grown fish as those hatched in the lake.

"But there ought to be a law to stop fishing with gill-nets, for the reason that down below here, in deep water, where they fish through the summer, it is estimated that at least one-third of those caught in hot weather are unfit for market, and are thrown away, which is an outrage. And then in the fall the gill-nets are set on the spawning reefs, just when and where the fish should be left undisturbed."

Bear & Ruth, of Sandusky, state that in 1883 their catch of whitefish from nine pound-nets, was seven and a half tons, and in 1884, from eleven pound-nets, ten tons.

"The planting of young fish is undoubtedly of great benefit to the fishing interests. Were it not for this the stock in the lake would rapidly decrease."

A. Bremilier, of Sandusky, gives the following figures: Catch of whitefish in forty pound-nets in 1883, sixty-six tons; in 1884, sixty-nine tons.

"I think there is positive proof of the benefit of the hatcheries, from the fact that during late years, say the last two or three, there have been a great many small fish caught—smaller than ever were caught before the planting was commenced in the lake. Another fact to be taken into account is that the facilities for catching are becoming greater every year, and if the

supply had not been kept up in some way, the stock must certainly have decreased, which is not now the case."

A. J. Gustavus, pound-net fisherman, of Huron, puts it in this light: "For every million of fry planted there are a million more chances for whitefish. I think the greatest results are to come, as the business is not yet old enough for us to expect much benefit."

E. D. Smith, of Marblehead, says: "I know the fish-hatching to be a grand thing, for the reason that I have caught thousands of whitefish this season not weighing over a pound to a pound and a half each and formerly never caught them. I believe these small fish are some of those planted from the hatcheries."

Fred Motrie of Port Clinton, says: "I fished six pounds in the fall of 1883, and five in the fall of 1884. Have no record of my whitefish catch for either fall, but know I caught more in 1884 than in 1883, perhaps 20 per cent. more. The hatcheries are undoubtedly a good thing and should be kept up. While the eggs are in the jars they are out of the way of the sturgeon, suckers and all the fish that live mostly by sucking up spawn; and when the young fish are turned loose they will look out for themselves."

Felix Courchaine, also of Port Clinton, says: "I did very well the past fall, in fact the fishing was the best it has been for years. I caught six tons with tweny-six gill-nets. I have every reason to believe that we are getting results from the plantings from the hatcheries; and why shouldn't we? The fry planted in this way stand an equal chance with those hatched in the lakes, and as for taking care of themselves, I think nature will look out for that. I should be sorry indeed to see the hatching of whitefish discontinued."

F. Perry, a practical gill-netter, of Port Clinton, says: "In the fall of 1883 my catch of whitefish from nineteen nets was one ton, and in the fall of 1884, from thirty-seven nets, six tons —six times the catch of the year previous, with double the nets, on the same grounds. I think we are getting great results from the planting of young fish, for before it was commenced whitefish were fast playing out. But now they are becoming more

plentiful again, and I know of no cause for it except the planting of the young in large numbers from the hatcheries."

From all the places named above, as well as other points on the lake, much more evidence of the same kind might be offered; but it would be merely a repetition of what has already been given. Accurate data showing the total whitefish catch of the lake for a term of years, or even for one season, would be almost impossible to obtain, from the fact that many fishermen classify their entire catch simply as "hard fish," "soft fish," etc., whitefish, of course, being included in the former. The statements, however, cover sufficient grounds to form a reliable basis for conclusions. They show that while there was no perceptible increase the past season in the whitefish runs at the extreme west end of the lake, there was a decided increase on the coast and island reefs further down, and a very marked increase in numbers still further down on the feeding grounds, in deeper water, where gill-nets are operated. On the whole, sufficient is shown to prove beyond a doubt that the aggregate catch was greater than for several years, that whitefish are decidedly on the increase in Lake Erie, and that the increase is simply the legitimate result of the work of the hatcheries. The removal from the lake every year of thousands and hundreds of thousands of adult fish, whether taken directly from the breeding grounds or not (the results are the same), must certainly ere this have caused a very material decrease in the stock but for the compensation of young from the hatcheries.

Northville, Mich.

HOW TO RESTORE OUR TROUT STREAMS.

BY J. S. VAN CLEEF.

In 1877 and the two following years, the supervisors of one of the counties of the State of New York lying east of the Hudson River, made appropriations for restocking the waters of the county with fish, and a committee of which the writer was the chairman was intrusted with the work.

The supply of fish from the State was liberal, and in each of the springs of 1878, 1879 and 1880 many thousand small fry of trout were distributed, those streams which had been noted trout streams in the past being especially favored.

In one of these years thirty-five streams were restocked. The fish were deposited under careful instructions, and considerable effort was made to protect the streams, and yet after the most careful inquiry, the committee has failed to hear of any practical benefit resulting from its efforts.

Many of these streams already abounded to some extent in trout, and it was hoped that the protection afforded after restocking would result in a marked increase of the fish; but that hope was not in any single instance realized, and the committee has been irresistibly forced to the conclusion that some force other than excessive fishing had led to the universal depletion of these streams, and that the same cause still existed to prevent their restoration.

After the fullest investigation and examination of these and other streams, I have become satisfied that the destruction of the trees bordering on these streams and the changed condition of the banks produced thereby, has resulted in the destruction of the natural harbors or hiding places of the trout, that this is the main cause of the depletion, and that until these harbors are restored, it will be useless to hope for any practical benefit from restocking them.

By giving a few of the facts which have led me to this conclusion, its correctness will, I think, be made apparent:

1. In the heart of the Catskills there is a natural trout lake of about twenty-five acres. Being too remote for successful protection, which has only been attempted within the last ten or twelve years, it has been for many years the resort of anglers the year round. Trout have been taken in enormous numbers through the ice, which usually lasts until May, and it has been the very paradise of poachers by day and by night. And yet the fish in this lake are substantially as abundant to-day as they have been for the past twenty years, and during all this time there has been no marked diminution of the trout.

This lake is fed by a stream which runs through a quarter of

a mile or more of wet, marshy land, which is so completely covered by large alders that it is almost impossible to penetrate them. In this stream the small fry and fish of one or two years' growth abound in myriads. In other words, the natural harbors and hiding places for the trout in and about this lake have been left undisturbed, and this is the secret of its continued wealth of trout.

2. Thirty or forty years ago a brook in Dutchess county, about five miles long, was noted for the abundance and size of its fish. The angler in the early spring was usually rewarded with a well filled creel, and from this little stream, which a child could jump across, trout were often taken of from one to two pounds in weight. Early in each summer the trout disappeared, only to appear again the next spring in equal numbers; near the center of this stream, it ran through a marsh, which so abounded in black alders that they protected it from approach. Through this marsh the stream was much broader and the water deeper than elsewhere, and the bed was composed of thin, deep mud, making wading impossible. Some twenty or more years ago the owner of this meadow cut down every alder, at the only point where the fish had found a safe refuge, and in a few years the trout, large and small, practically disappeared, and though recent efforts have been made to restore and restock this stream, under full protection, they have substantially failed.

3. In one of the principal streams running through Ulster and Sullivan counties, it has been my privilege to fish many times during the last twenty-five years. Here were two pools which always furnished rare sport, and the adjacent pools were always full of fish. On one of the banks of each of these pools the trees had been left standing, their roots had preserved the upper portion of the bank, but below these roots the ground had been washed away, so that deep hiding places were thus formed for the trout. It was very seldom that one or more large fish failed to rise to the fly at these points.

Some twelve or fifteen years ago these trees were removed, the stumps decayed, the bank fell in, the fish no longer had a refuge, and since that time the angler has been fortunate if he has raised a fingerling at or near either of these points.

The conditions as to the waterflow are still relatively the same in all three of these waters, the spawning grounds are unchanged, the only difference is in the harbors for the trout, which are unchanged in the first, totally destroyed in the second, and partially so in the third. And the depletion of the fish has been in precise proportion to such destruction.

Lest these may be regarded as somewhat isolated cases, I will cite two more.

Near the center of Dutchess county a brook rises in the side of a small mountain, at the base of which it enters a swamp through which it runs, with occasional openings for two or three miles, where it iscompletely protected by the trees and bushes, which have never been disturbed. In these open places and below this swamp, where for a distance of several miles there are but few places where the stream cannot be reached, it has been and still is freely fished, and yet there has been no serious diminution in the number or size of the fish. While other streams have failed, this one has always yielded good sport, trout of from one to two pounds being frequently taken.

In the eastern part of the same county there is a long, sluggish stream running for miles through a marsh. Its very name, "Swamp River," indicates its character. Its bottom is one long stretch of ooze ; its banks are almost everywhere covered with a dense growth of bushes. It has always been noted for the size of its trout, but on account of the difficulty of access they are seldom taken. It is fed by several tributaries of three or four miles or more in length, as well as numerous little streams, all of which are open and freely fished, and they are all good trout brooks.

As soon as the water in these brooks becomes low, the trout disappear, but where? The water flow is increased by the generous rain, they appear again in large numbers, and at such times large fish is often taken even in the smallest tributaries.

This last instance is especially interesting, as it shows that when the streams are full of water the trout will travel a long distance from their haunts, and that when warned of danger by the receding of the waters, the instinct of self-preservation leads them to hasten back to them.

Unfortunately very many of our most noted streams are not favored with lowlands and swamps, where the fish can find safe refuge, and in these and our mountain streams especially we must unquestionably lookto the larger pools in time of drouth, as the principal places of refuge for the trout, and when these are accessible from every point, the trees are cut and the banks fall in, so that every pool assumes about the shape of a huge wash basin. No system of protection will prevent their being dragged with nets in the night, or the commission of other depredations almost equally destructive of the fish.

I have the most abundant proof that fishing with nets has been constantly done in our finest Catskill streams, such as the Beaverkill, Neversink and Rondout, and where the trout cannot take refuge under the banks, they must necessarily be taken by the net.

I have not referred to the foregoing facts as in any wise new, nor in the belief that they may have escaped the observation of anglers; but rather that their significance has not been generally understood or appreciated.

When the trout become scarce, the reason most commonly given and accepted is that "the stream is fished out."

It is not the rod, however, but the axe and the net that have ruined and are ruining our streams.

The natural homes of the trout are the sluggish waters of the swamp, cold and pure, with their bed of ooze and sheltered bank, or in our upland streams the deep cavities under banks or roots.

We have destroyed his home, and he has perished. Let us restore it to him again, and he will thrive.

I believe it possible to restore most of our streams, where the waterflow has not decreased too greatly, especially when they are under the control of clubs or associations who can and will make the effort.

The remedy which I suggest is briefly as follows:

First—Prohibit the further destruction of either tree or bush upon or near the bank of the stream.

Second—Where the soil is wet and suitable, protect the pools by an abundant growth of alders or other bushes.

Third—Plant trees on the banks wherever feasible, especially

where their roots will protect the surface of the ground, and at the same time permit the washing away of the soil underneath, so that large hollows may be formed as hiding places for the fish.

Fourth—In each year, after the spring freshets are over, protect every pool as far as practicable by placing stumps, or trees or bushes in them, so that fishing with nets will be impossible. And also that the trout may be provided with artificial harbors until the natural ones are again restored.

Fifth—As far as possible prohibit fishing with bait, so that the haunts of the trout may be safe against invasion by the hook.

Let the home of the trout be regarded as his castle. Entice him from it if you can, but do not invade it.

Poughkeepsie, N. Y.

DOES TRANSPLANTING AFFECT THE FOOD OR GAME QUALITIES OF CERTAIN FISHES?

BY A. N. CHENEY.

This rather imposing caption opens a wide field with many ramifications, and I cannot hope to do more than skirmish around the edges of the subject, but hope thereby to induce others to give from their personal knowledge that which will cover more of the field. In one sense it is not a new question to the members of the American Fisheries Society or the writer, for the effect of food upon our game fishes has been discussed, and it is a self-evident proposition that a well-fed fish, transplanted or otherwise, makes the best food fish; therefore, it is safe to say that if fish are taken from lean waters and planted in fat waters, their food qualities will be improved.

In another sense, the effect transplanting has upon the game

qualities of our game fish I do not remember to have read of being discussed. The question has been asked me a number of times, in one or both forms, by angling friends, and quite recently the matter was again brought to my attention by a letter from a gentleman of long and varied experience as an angler, who asked if I had found the black bass gamer on the hook in waters to which they were alien, than in waters to which they were native; and he answered the question from his own experience, by saying he had so found them. To me it seems a case of cause and effect, for an abundance of food and game qualities are inseparable, and go hand and hand to produce this desired result. I never caught a half-starved fish that exhibited marked game qualities on the hook, and the test of gameness is accepted as the power of a hooked fish to fight or resist capture by the angler. I don't believe a fish can fight on a stomach that is habitually empty any better than a man whose stomach is in the same state, for there is a heap of courage in a good dinner, which is increased by the knowledge that the good dinners are to be a regular thing in the future.

I can, perhaps, do no better than give a few results of fish transplanting that have come under my own observation, and I do so, looking with the eyes of an angler rather than with those of a fish-culturist.

Before going further I might answer the question asked by the friend above mentioned, by stating that the gamest black bass that ever I caught were taken from waters to which the fish were native, and I never caught black bass that were in better condition than these same fish. I have taken bass with more fat, but it was abnormal fat that took away the dash and vigor that characterize the bass, and the angler had to overcome but little more than the avoirdupois of the fish; but the loss to the rod was a gain to the gridiron.

Saratoga lake black bass stocked Effner lake. Effner lake bass stocked Schroon lake, Luzern lake and the Hudson, Schroon and Sacandaga rivers. It would not be just to compare lake bass with river bass; but Saratoga lake and Schroon lake bass are gamer than Effner lake bass. There is, apparently, little difference in the temperature and clearness of the

water in these lakes, but Effner lake seems to have the poorest supply of fish food. Lake George black bass stocked Long pond, and afterward Long pond stocked Round pond. Long pond bass are least gamy of the fish in the three waters, but they are far the largest. Long pond is just a mass of fish food, and the water is warm and thick. On the contrary, Round pond, forty rods away, is a great spring of clear, cold water, lacking outlet or inlet, with an abundance of fish food, and the bass therein, while not exceeding in size the Lake George bass, fight like fiends when hooked.

Without further multiplying instances, I think it prudent to say that when black bass in alien waters are found to possess superior game qualities, it is because they have found better pasturage or better water than in the homestead.

Hudson river pike (*E. lucius*) were used to stock Schroon lake and river, and both furnish pike of greater growth than the parent waters, but one cannot compare their game qualities, for they have none.

It is natural, perhaps, that the quiet lake waters should be more conducive to aldermanic proportions in the pike than is the rapid river water, but a recent local newspaper states that Schroon river has produced a larger pike than the lake.

Oneida pond was also stocked with pike from the Hudson, and it has yielded these fresh-water sharks of greater size than those from any of the other waters I have named. The pond is small and the pike soon cleaned out the food, and then commenced a warfare of the survival of the one with the largest mouth. The large fish have been caught, and those that remain are all of the same size, with the clefts in the mouth yearning to extend back to the dorsal fin.

I have somewhere seen a statement, and I think it was in one of the reports of the New York State Fish Commission, that whenever the New York lakes containing a remnant of lake trout have had a contribution of lake trout fry from the great lakes, the addition or deposit has increased the average size of the trout in such waters. This, at least, is the idea that has been fixed in my mind from reading the statement; but I do not think that it was coupled with, or contingent upon, an ad-

ditional supply of fish food. I have closely watched this improvement in the trout of Lake George, New York. Before the lake was restocked by the State, the trout were very poor and small, and because of the gradual taper from their heads to their tails were called "wedges" by the fishermen. I do not know as they appeared starved so much as they appeared dwarfed. Every spring during the trolling season when the trout were "on top," quantities of small whitefish were seen at the surface of the water, so the lake was not entirely barren of food for the native trout. Five years after the State made the first deposit of trout fry, it planted some whitefish for trout food. There was a marked improvement in the trout almost from the first planting of fry, and each year since the average in size of the catch has been larger and the condition of the trout better. I have often wondered if this was entirely owing to the food, for the anglers can discover no increase in the whitefish fry on the surface in the spring.

In other words, does not the fresh blood or out-cross improve the natives and leaven the whole. Among the mammals, this fresh blood is sometimes necessary to prevent a "going to seed," and even man in families of high degree deteriorates or "peters out" occasionally from too much blue blood and not enough red. I know it is presumption on my part to intimate that there is any affinity between the workings of warm blood —particularly the blue kind—in man, and the workings of cold blood in fishes, and I only do it to ask the scientists here gathered together, if it is possible for the infusion of fresh blood to act upon and improve and strengthen fishes that have been in breeding for ages in circumscribed waters. Whatever scientists may say about the infusion of fresh fish blood, which would apply only in certain cases, I am satisfied that fish in alien waters improve in food and game qualities only when they find better feed or better water, which causes a more vigorous condition, which is the gameness desired by anglers.

Glens Falls, N. Y.

Mr. MATHER—The observations of Mr. Cheney correspond with those of others who have given attention to this subject.

As a rule, a transplanted animal does either better or worse than if left in its native place, especially if carried to a considerable distance. The brown trout, *Salmo fario*, of Europe, grow rapidly here, while our eastern trout, *Salvelinus fontinalis*, have made rapid growth in Germany. The German carp is another instance of rapid growth after transplanting, for in America they have far exceeded their growth in their native land. I do not know the history of the black bass in Saratoga and Effner lakes, to which Mr. Cheney refers, and which he claims stocked the Hudson. I have been under the impression that the first black bass in the Hudson river came down the Erie canal when it was opened, some fifty years ago ; but they have never increased much below Troy during this time.

ON SOME OF THE PROTECTIVE CONTRIVANCES DEVELOPED BY AND IN CONNECTION WITH THE OVA OF VARIOUS SPECIES OF FISHES.

BY JOHN A. RYDER.

Mr. President and Gentlemen : A discussion of the apparatus by means of which the ova of fishes are protected will, I think, be of interest to the members of this society. I will roughly classify the eggs of fishes into four divisions, and call one of the groups "buoyant eggs," another "adhesive eggs," another "suspended eggs," and the fourth "transported eggs," the latter class embracing such as are hatched in the mouth or in receptacles especially developed on the outside of the abdomen or under the tail of the parent fish—usually the male—in nests built by the males, or viviparously developed in the ovary of the oviduct of the mother.

The egg of the cod will serve as the type of the first group. It is without an oil-drop, but is buoyant notwithstanding. There

is another type of buoyant egg, similar to that of the cod, but with an oil-drop opposite the germinal pole, where the embryo develops, consequently the egg is rendered buoyant. That type is represented by the eggs of the Spanish mackerel, of the bonito in the Chesapeake bay, and of the cusk and a number of other marine fishes.

The second group, which I have called adhesive, is represented very well by the eggs of the goldfish, which adhere singly to plants and weeds. Other species whose eggs are similar to those of the goldfish, are the blennies, which lay eggs in radiating adherent groups. The gobies have a curiously shaped oval egg, almost conical at either end, with tufts at one of their tips. These tufts seem to be made up of small filaments. In other species, too, the eggs are adherent, as is the case with those of the cunning little *Gobiesox*. In other cases the eggs are held together in enormously extended bands or membranes, which float, as in the case of the goosefish or fishing frog. Yet other eggs are held together in narrow strips, and adhere together by means of an exterior mucous or sticky envelope, just within which again is a very thick, elastic, perforated membrane, as the eggs of the yellow perch. This sticky substance glues the round eggs together at their points of contact, leaving spaces between the ova, enabling the water to pass directly through the openings which are thus left in the bands of eggs. This form of band of adherent eggs is found in the yellow perch, in contrast to which may be cited the white perch, whose eggs adhere by a mucous secretion which seems to glide down on one side to the point where the attachment takes place, and where this mucous substance hardens under water, firmly fixing the egg to the foreign bodies.

The eggs of the slime-eels or hags, which are parasitic upon the cod and on sharks, are also peculiar. These eggs are supplied with a bundle of hooks at each end. I am not sure of the special function of these hooks, but it is probably for suspending the eggs in some way. There are other cases in which adherent eggs are held together in large masses as thick as a man's hand, or they may be spread out over a flat surface. This is the case with the eggs of the catfish. In these, however, we find

a contrivance which is peculiarly adapted for protecting the eggs against the violent motions made by the male who ærates, attends and incubates the eggs. In these eggs there is an inner true egg membrane, and an exterior mucous adhesive layer, separated from the inner one by elastic pillars, placed at intervals, so that the resulting arrangement is an extremely elastic one, and yields readily to the motions made by the male with his fins. In this case the eggs adhere together in masses very much the same way as in the eggs of the frogs.

There is yet another singular contrivance, which was first described by Professor Jeffries Wyman, of Boston. This is found in a species of the armored catfish of South America. In this case (*Aspredo*) the male fish is provided with a numerous series of little stalks, formed on the under surface of the abdomen, and the cup-like extremities of the stalks into which the eggs are received are supplied with capillary vessels, an arrangement being thus developed which constitutes not only a supporting stalk, but also a kind of placenta. It is said—although I am not sure that the evidence is very trustworthy—that one species of the gar lays its eggs in strings in a single row, like the common toad. There are other cases in which the ova are uncovered and directly adherent to the abdomen or under side of the tail, as in the case of some of the pipe fishes of Europe. In some of our American species of pipe fishes the eggs adhere beneath the tail in a couple of rows, but are covered by expanded folds of the skin. There are other cases in which the eggs are carried into a pouch formed by the ventral fins. In other species there exists an abdominal or rather caudal pouch which opens just behind the vent of the male, and into which the eggs are received and incubated. In one instance a fish of this class (*Hippocampus*) hatched out under my observation about 150 ova; the drove of embryo sea horses which were finally set free in the aquarium, were an interesting study.

Then the number of species which suspend their eggs is quite considerable. The black, leathery case of the common oviparous ray has four filamentous horns, one at each corner, which wind around plants and suspend the eggs to weeds, so that as the tide sweeps by these horns, which have openings in them,

fresh water is carried into the case to aerate the embryo and favor its incubation. This peculiar egg case is formed in the end of the oviduct, which is different from the egg membrane occurring in any of the true bony or Teleost fishes, since it is formed of horizontally interwoven fibres. The egg case of the cestracion, or Port Jackson shark, is formed in the same way, but instead of being flat and quadrangular, is twisted into a spiral. I am not positive, however, that the eggs of the Port Jackson shark are suspended. Another type is found in the *Scombere-socidæ*, in which the entire egg membrane is covered with strong filaments, which wind round each other and intertwine with the similar filaments of contiguous eggs, which are consequently, held together and suspended, sometimes in masses several inches in length, such masses being commonly found in great numbers hanging to the meshes of pound nets during July and August. The egg itself measures one-eighth of an inch in diameter. There is another somewhat similar type in which the egg is very much smaller. This is the egg of one of the commonest fishes found in the waters tributary to the Chesapeake bay, viz., *Menidia*, one of the *Antherinidæ*. They are provided with four filaments, attached to one side of the egg, by which they are in like manner suspended and held together in strings. Again, there are still other types in which the ova are hatched in the mouth, as in the case of *Arünæ*, or marine catfishes. Their eggs are very few in number, but they are as large as those of a robin. Some of the smaller blennies take advantage of a dead oyster shell in which to conceal and deposit their adherent eggs.

There are yet other cases in which the male builds a nest. One of the most extraordinary instances of this kind is the common four spine stickleback (*Apeltes*), which I described four years ago. The male, which is much smaller than the female, has a pouch on the right side of the rectum, from which is poured out a viscid secretion, and which is spun out into threads fitfully by the animal, as he goes around a bunch of water weeds like a bobbin to build a little basket-like nest for the eggs. After he has induced the female to oviposit, he tends the eggs very faithfully until they hatch. Some investigators go so far as to say that after the eggs are hatched, the male stickleback will

follow the young ones which leave the nest too young to take care of themselves, and put them back in the little cradle in which they were born, to thus prevent their being prematurely devoured by other fishes. At one side of the eggs of the stickleback there are minute button-like excrescences. These are also found on the eggs of European species. One of the South American catfishes (*Callicthys*) also builds a nest, but the nature of it I am not familiar with. The male of the paradise-fish ejects from its mouth bubbles of mucilaginous matter, which floats in the form of a cake, and on this the eggs are deposited and hatched out. The *Antennarius* and the fishing frogs of the deeper ocean deposit their eggs on floating masses of sargossa weed.

We are, of course, all aware of the number of forms of salmonoids which prepare beds for the better protection of their eggs. The same may be said also of the black bass, sun perch and lampreys.

I also wish to call your attention to the physical behavior of different species of ova as seen in several groups. This consists of the disposition manifested by certain types of eggs to place the germinal disk in some particular position with reference to the yolk. This disk is directed almost downward in light or buoyant eggs. In the case of the salmon, whose eggs are very heavy, the disk rests on the top of the yolk, and the larger oil drops lie just underneath the germinal disk. In the case of the shad the germinal disk always lies at one side of the yolk, no matter in what position the eggs may be placed. The buoyancy of the oil drops in the salmon's egg keeps the germinal disk directed upward. In the Spanish mackerel its buoyancy keeps the disk directed downward. This peculiarity has some physiological significance, but I do not know what it may be, unless it be for the purpose of the better protection of the egg, so that the embryo may have a better chance to survive.

It was remarked yesterday in Mr. Mather's paper that the eggs of the smelt were remarkably hardy and would stand usage which other ova would not. This calls to my mind the capacity which some eggs have for resisting adverse conditions. There are species which, in order to hatch them out successfully, it is only necessary to change the water once in three or four hours, as, for

example, in the case of the stickleback. With the shad this method would not answer. Nor could the ova of salmon be successfully hatched out by such treatment. What I have said on this point shows, I think, that there is a great difference in the power of resistance to adverse conditions manifested by different species of eggs under similar conditions. In the case of the silver gar, for instance, I had at last only three eggs with which to work out the later stages of development, and, although I had them under the microscope fully twenty successive times, each time brushing off the accumulations of filth which would lodge among the filaments covering the egg membrane, yet during all these manipulations the normal development of the embryos remained unimpaired.

I will call your attention to the viviparous types. The one which I have worked out most fully is the genus *Gambusia*. The parent fishes were from 1½ inches to 1¾ inches in length, and are found along the Chesapeake bay and its smaller southern tributaries. This is a fresh-water, or at least anadromous vivaparous species, spawning in July and August. The ovary is lodged in the body cavity, and the vessels pass backward to it, like the subdivided stem in a bunch of grapes to the single berries, each one of the follicles in which the single eggs grow receives a twig from the main vessel and is covered with a network of vessels, which branch off from the main twig which enters it, and just at the point where the vessel enters the single follicle, there is a large round opening which answers to the micropyle of the ordinary fish egg laid directly in the water. The egg of *Gambusia* is, however, without a true egg membrane, the thin vascular follicle takes its place. The little fish develops within the follicle, in which fertilization also takes place, the spermatozoa finding their way to the egg through the round pore in the follicle spoken of, the male conveying his milt into the ovary by means of an actual copulation with the female by means of his prolonged anal fin. The development goes on until the fish becomes active and the yolk-sac is aborbed. The young fish then ruptures the follicle in which it is imprisoned, and slips out through the abdominal pore, perfectly capable of taking care

of itself. Not more than twenty or twenty-five individuals are produced at one spawning.

In another type, *Anibleps*, a form described by Professor Jeffries Wyman, the yolk-sac itself is covered with villi, and, strange to say, continues to grow for some time after the yolk has been absorbed, but the reason for this I am at a loss to understand. It may, however, be that the function of the empty yolk-sac is in this case somewhat similar to that of a placenta.

The eggs of the surf perches of the west coast are developed in membranous curtain-like folds of the upper wall of the ovarian sack. These membranes have a longitudinal direction, and after the female is pregnant, and the embryos are somewhat advanced in development, they hang down between the embryos, the latter being packed into the ovary somewhat like sardines in a box. The peculiarity about the development of the young in the ovary is that the vertical fins of the fœtuses soon acquire an exaggerated development and have a special set of blood vessels sent to them, the fins also develop marginal prolongations which become highly vascular, but afterward atrophy. This arrangement, as well as the highly vascular skin of the fœtuses, clearly has relation to the respiration of the embryos while in the ovary. Another peculiarity about this type is the enormous development in the embryos of the back part of the intestine beyond anything I have found in any other kind of fish embryos. This hypertrophy of the intestine is of transient character, because this structure afterward gradually diminishes in proportional size, and acquires the relative proportion in respect to its diameter found in the adult fishes in which there is no such an exaggerated development of the intestine. The earlier writers, Girard and others, who described these forms, mistook this projecting back part of the intestine for a yolk bag. The fact, however, is, as we know from the figures which are in existence, that this was not a true yolk bag, but merely the intestine developed as I have described it to you, with its terminal part thrust down and backward, so as to project below the abdominal profile, somewhat after the manner of a yolk bag.

Washington, D. C.

THE USE OF THE THROWING STICK BY THE ESQUIMAUX.

Everything that exists should have a reason for its existence; so I must tell you why I am before you to-day. Prof. Goode, the assistant director of this museum, came up on my balcony the other day, and asked me if I would not read a short paper to you on some one of my studies connected with fishing among the savage people of the world. So it is at Prof. Goode's request that I am here this afternoon, to say a few words about the use of the instrument known as the throwing-stick by the Esquimau in fishing.

In the east north range of the National Museum you will see many specimens of modern apparatus for capturing fish, and probably in the next case you will see the savage apparatus for the same purpose; and you will be astonished over and over again at the similarity between the modern and savage forms.

Scarcely a week passes in which some patent office examiner does not come to the museum to examine the collections to see whether that for which a patent has been claimed is not merely a duplicate of something invented years and years ago. Patents have been claimed for things used in the days of Abraham, Isaac and Jacob.

One of the most interesting implements invented by savages is the little wooden instrument which I am now going to show and explain to you.

In southwestern Greenland, the eastern part of Labrador, mouth of the McKenzie river, Point Barrow, Bristol bay, Norton sound and Kodiac island this instrument is in use. From Sitka to Columbia river grow the great cedar trees, out of which these immense dugout canoes are made, in which the navigator carries a long spear, twelve or fifteen feet in length, and on the end of that a harpoon used for whales.

The Esquimau almost lives in his kyak or skin boat, and is so securely fastened in that any accident to the boat is certain death to him. Were he to use his spear alone in making a lunge, he would overturn his boat and expose himself to greater

danger. So he is compelled to make use of some means which will both answer the purpose of giving the required force to his spear and avoid the danger incurred without its use. He cannot use the bow in giving the required force to the spear, necessary in harpooning the seal. It is very difficult to use either a bow or firearm in a boat. So he is driven to the use of this invention, happily hitting upon the device of the throwing-stick.

The principle upon which the instrument is used, is this: The fisher takes the throwing-stick in his right hand, usually with spear firmly pressed down in the groove of the stick with the fingers. He then brings it up, throwing it a little back over the right shoulder. There is a little hook, generally of ivory, at the upper end of the groove of the stick in which the spear rests, which fits in a notch made in the end of the spear. After getting the weapon in position, without moving his body, he gives a swift and abrupt motion forward, the spear darting from the throwing-stick with great rapidity, the fingers having been raised to allow its passage.

An interesting fact has grown out of the study of the throwing-stick, namely, that it is in use in only three different regions of the world: In Australia in a very simple form, with a hole for the forefinger; in South America and among the Esquimaux of North America. In those three localities alone is it used.

I shall give you a brief description of some individual specimens, and let you look at the others when I am through talking. We will commence with this one from Greenland (showing specimen). There is a groove for the spear, notches on opposite sides for thumb and forefinger, a small hole midway in the groove, near the notches, for a peg, which is inserted in the shaft of the spear. Instead of a hook at the opposite end, there is an oblique hole in the ivory, into which another peg near the end of the spear fits. The next is from Cumberland gulf (showing specimen). Very clumsy and roughly made, a groove for the spear, a hole for the forefinger, a notch for the thumb, also three notches on opposite side for the fingers. A goose-spear is also used with this one, which when thrown at the goose just as likely hits the gander. Ungava bay (showing specimen).

Shaped very much like a fiddle-head ; a hole for the forefinger. The bend is a great advantage to the hunter, as it increases the facility of launching the weapon, and a spear, when used with this, will go a great distance. Mouth of McKenzie river (showing specimen). Most primitive of all the collection, a very rude furrow for the spear, a hole for the forefinger.

The Anderson river is the dividing line between the eastern and western Esquimaux. From that line going westward and southward the throwing-stick improves very rapidly. The form begins to greatly resemble the razor strop handle, with hook or peg at the end of the grove for catching the notch in the end of the spear, groove, hole for the forefinger, notch for the thumb, and in some instances ivory pegs are inserted, thus making spaces for the fingers, affording a better grasp.

In Alaska, great headlands project out into the water, thus creating barriers among the people and causing sharp dividing lines and differences in the forms and degree of elaboration of the throwing-stick. After passing the Island of Nunivak, the finger hole disappears, and is not again seen until we come to Kodiak island toward the east. From one of the Aleutian islands we have a left-handed throwing-stick with hole for the forefinger, and another left-handed specimen from Nunivak, razor strop handle, no hole for forefinger, thumb notch and pegs on opposite side making finger spaces.

I will not try to tell you how far back in the past this invention must have been made. References are made in old classical literature to one or two forms of contrivances for giving additional force to weapons used in throwing or darting, and I think probably this device is the descendant or offspring of something of that kind for giving additional momentum, rather than a transformation of the bow.

By using the throwing-stick with the spear, the force is given to that weapon which the bow gives the arrow, or the sling to the missile thrown. So that this little instrument lends its aid in the three regions mentioned, supplying a great need, probably to be met by no other means.

Washington, D. C.

THE CHIEF CHARACTERISTICS OF THE NORTH AMERICAN FISH FAUNA.

BY PROF. THEODORE GILL.

I do not think that I can appropriate the time which I was requested to devote to a communication for your society more profitably, than by inviting your attention to some of the characteristic features of the North American fish fauna.

If we include the marine as well as the fresh-water fishes in our study, we would have to consider the constituents of four primary different geographical divisions or realms, and we are therefore compelled by the limits of time to restrict ourselves to the consideration of the fresh-water forms alone. America, north of Mexico, forms a primary terrestrio-aquatic realm which has been variously designated as the North American, Nearctic and Anglogæan region or realm. It is one of the very richest of all in fresh-water types, considerably over six hundred species living exclusively, or nearly so, in the rivers and lakes, and these represent nearly one hundred and fifty genera and about thirty-four families. It is a large exhibit compared with the fauna of any of the other realms.

If we notice the constituents of this North American fauna, we find that they may be segregated into two primary categories. A considerable number of the families are shared with European and Northern Asia, and many may be designated as the Arctogean, while an exceptional number of families are peculiar to our continent. Those peculiar are the Amiidæ, Hyodontidæ, Percopsidæ, Amblyopsidæ, Aphredoderidæ, Elassomidæ and Centrarchidæ, and several well-marked sub-families are also limited to the regions. Such are the Campostominæ, Exoglossinæ, Plagopterinæ, Etheostominæ, Haploidinotinæ and Hysterocarpinæ. It is possible that even the Lepidosteidæ are at present peculiar, but Dr. Bleeker has named as such a species, based upon a Chinese drawing of a fish supposed to have been obtained in China. Fifteen families represented chiefly by marine species, but with members also in the fresh water, are the Petromyzontids, Silurids, Clupeids, Dorosomids, Argentinids, Sal-

monids, Cyprinodontids, Anguillids, Gasterosteids, Atherinids, Labracids, Sciænids, Embiotocids, Cottids and Gadids, and among these we find the families which are represented by the same genera in both the old and new worlds.

The fresh-water species and even the genera of most of these families are, however, to a large extent, peculiar to the interior waters ; of the others, (1) some are anadromous, like certain of the Salmonids, Clupeids and Labracids ; (2) others inhabit fresh and salt water almost indifferently, as the Dorosomids, many Cyprinodontids, and most Gasterosteids, and (3) one (the eel) perhaps should be considered as a salt-water rather than a fresh-water species, inasmuch as it is catadromous and appears to breed only in the sea. Conversely, these fishes which resort to fresh water to spawn and therein spend their early days may be considered to be fresh-water forms. If all species which, to some extent, run up into fresh water were included, the list might be very greatly increased, and it is by this inclusion of these species running up into fresh water that the faunas of other countries have been unduly enhanced.

If now we consider the bearings of the known facts, we may deduce the following conclusions:

(1) The number of family types peculiar, or almost peculiar, to North America and the very large number of genera also confined to the temperate and cold regions of the continent, indicate that the region specified has such characteristics as to en title it to be considered a primary geographical division of the globe, which will appropriately bear the name of the Anglogæan realm, inasmuch as its habitable portions are occupied by the largest portion of the Anglo-Saxon race. Several of the families peculiar to this realm are almost coincident in their range with its limits, and such coincidence is especially manifested in the case of the family of Centrarchids.

(2) If we compare the constituency of our ichthyic fauna with that of the Eurasiatic realm, we find several notable contrasts. The North American is distinguished by the great development of Acanthopterygian types, while there are few in the Eurasiatic one. North America has as many as 180 species, while nineteen are all that have been credited to Eurasia. The Centrar-

chids and certain little fishes related to the perches, which have been distinguished as Etheostomines, are very characteristic for the American fauna, and are among the most prominent features, while those types are entirely wanting in Europe. The catfishes so abundant in America, and of which there are at least twenty-six species, are represented by only one in Europe, and even that one is of an entirely different type.

Another noteworthy contrast is exhibited by the Cyprinids. The species of Europe and Asia are almost all of large size, and are the most conspicuous fresh-water fishes of that region, whereas the American species of the family are almost all small and even of minute size, and (if we except the Pacific slope, which has features in common with Eurasia) there are not more than a couple of what can be called large species of the family in the entire region. It is indeed to a related family, the suckers or Catastomids (entirely wanting in Europe proper), that we have to look for analogue of the European Cyprinids. Among them we havs forms equalling in size the European carp, barbel and others, and some quite similar in superficial appearance. Summing up all the species we find that Europe has been accredited with 360 fresh-water fishes, while the North American fauna has at least 625.

The number of the genera common to North America and Europe is indeed extremely few, and the idea suggested by some recent authors, that the North American fauna is merely a subdivision of a common Arctogean, Triarctic or Holarctic realm, is entirely traversed and negatived by the fish fauna.

It is also especially noteworthy that a number of the types peculiar to America are distinguished by the care which the parents take of their young; whereas the European forms are generally indifferent to the future progeny, and after spawning, leave the eggs to take care of themselves. In this connection it may be recalled to the American Fisheries Society, that the care of the eggs and young is accompanied by an apparent diminution of the number of eggs, and we have a sort of analogy in this respect to the relation between fish-culture and nature. The fish-culturists assume the parts which, in nature, is exercised by the attentive parent, and the eggs and young being pro-

vided for, stand a less danger of destruction, and consequently in such, the ratio between the eggs laid and fertilized and the young matured, is very much less than that between the number of eggs of the indifferent parents and that of other progeny matured.

SOME OBJECTIVE POINTS IN FISH-CULTURE.

BY M. M'DONALD.

I do not propose in this paper here presented to the consideration of the members of the American Fisheries Society, either to describe the apparatus, discuss the methods, or estimate the results accomplished by the work of artificial propagation and planting of fish in the inland, river and coast waters of the United States.

These topics have been and will be discussed during the progress of our meetings, by gentlemen much better qualified to instruct and interest you than I profess to be.

Your attention is invited not to what fish-culture has already accomplished, but rather to what remains to be done, before we can consider its mission ended.

It is proposed, as briefly as may be, to indicate the objective points yet unattained, toward which our efforts, energies and investigations should be directed, and to suggest some of the agencies which must be invoked, and which must co-operate in dealing with the important question: How shall we restore our inland, coast and ocean fisheries to their former abundance and maintain them at a maximum of production?

Less than a generation ago fish-culture was an art rude in appliances, crude in its methods, sentimental rather than practical in its aims, and insignificant in its results. To-day it confronts us as an industrial and economical question of the first rank—too grave in its issues, too vital in its relations to be ignored or disregarded.

In its inception, the artificial propagation of certain species of *Salmonidæ*, with the view of planting them in depleted streams in which the species was native or indigenous, was the aim and limit of fish-culture as then understood and practiced.

The fish-culture of to-day, broader in its aims, grander in its achievements, more rational in its methods and infinite in its possibilities, finds in the artificial propagation and planting of fish but one of the means to an end. This resource places at our command, in measure without stint, the seed of the harvest; we may scatter it broadcast in rivulet and river, in pond and lake and tidal waters, but whether the seed thus sown will grow and ripen to a full fruition depends upon conditions which must be studied, interpreted and defined, and where unfavorable, modified or eliminated.

We should be prepared, therefore, to appreciate and provide for the wide range of inquiry and investigation we, as a society, are called upon to suggest, to foster, or to inaugurate.

PHYSICAL AND BIOLOGICAL INVESTIGATIONS.

Each species with which we have to deal has a life history of its own. In its manner or mode of reproduction and development, in its habits, food and habitat, it is in essential relations to its environment. Our success in repopulating our rivers with species indigenous to them and in acclimating in new waters species which are valuable for food or sport, will be measured by the fidelity and precision with which we study, interpret and apply the lessons taught us by the naturalist, the biologist, the physicist and the chemist.

It should be the business of this society to enlist in its service or to invite to co-operation in its work, all those whose intellectual activities find occupation and engrossment in studies and investigations which may seem to the casual observer to have no practical application, but which are just as essential to the accomplishment of the work we have set before us, as is the artificial propagation and planting of fish; for upon the right interpretation of such investigations depends success or failure in the practical work of fish-culture.

The biologist with his microscope, is needed to reveal to eye and comprehension the marvellous story of embryonic development, and interpret and define the conditions which are favorable or unfavorable. With the thermometer in hand, the physicist marks out the paths traversed by the wandering schools of fish in the pathless ocean, and circumscribes the limits beyond which they may not pass.

With balance and reagents, the chemist appreciates those infinitesimal differences of salinty or composition which may or do determine the presence or absence of certain species in certain areas of water. Nearly all departments of science may be, indeed must he, laid under contribution to furnish us the data upon which to build our conclusions.

REGULATION AND PROTECTION OF THE FISHERIES BY LAW.

Another important subject which should enlist the attention and engage the efforts of this society, is the securing, through State or Federal legislation, of the enactment and enforcement of such laws as will regulate the seasons of fishing, the methods and apparatus of capture, and conserve, as far as may be, favorable natural conditions of reproduction.

It is true there are upon our statute books now laws without number, seeking to regulate the fisheries. Usually, these laws are dead letters, mere forceless verbiage. In some cases framed in ignorance, or dictated by the private interest which, for the time, dominates in the legislative assembly, they invite the very evils they seek to remedy.

Public sentiment everywhere has awakened to the necessity of rational legislation in reference to our fisheries. The fish-cultural and fish-protective associations, and the numerous fishing or angling clubs, in organized and active existence in all the States, are composed of men who are intelligent, educated and interested. They largely mould, direct and voice the public sentiment which suggests and controls legislation. It is the function—I may say it is the business—of this society, both as a body and through individual members and co-workers, to stimulate inquiry and investigation in every direction, to collect

digest and interpret the data thus obtained, and be prepared to suggest and recommend necessary legislation in the interest of the fisheries.

To secure the enactment of such legislation, all these associations, societies and clubs should be brought into sympathy with our aims, and into co-operation with our efforts. As organized bodies or as individual members, they should become integral factors in the organization and work of this society.

STATISTICS OF THE FISHERIES.

A third important objective point to be aimed at by this society is to secure the institution by the National Government of measures to collect each season complete statistical returns of the fisheries. Such data are of the greatest importance in giving us a measure of the improvement or depreciation of our fisheries year by year, and in appreciating and interpreting local fluctuations in the fisheries. I may add that the want of authentic statistical data of the sea fisheries has already cost the general Government not less than $5,000,000 under the provisions of the reciprocity treaty now in force between the United States and Canada.

Like questions of reciprocity and compensation may arise at any time between our Government and the Canadian, or other foreign governments. An accurate statistical presentation of the extent and value of our own sea fisheries, which we should always be prepared to furnish, will be our best protection against the extravagant demands and unwarranted concessions which have been asked and yielded in the name of reciprocity.

A consideration of the objective points in fish-culture, a few of which are here briefly brought to your attention, will give some idea of the extent of the field which is to be exploited before this society, and the agencies which it may enlist in organized and concerted action, shall have accomplished the mission committed to it.

Of the importance of this mission I need hardly speak. The necessity of utilizing every food resource of land and water grows more urgent as populations increase. It is an economical necessity that sea and lake, pond and river, should be

brought up to and maintained at a maximum production, and to this society is largely committed the satisfactory solution of this important question of political economy. When the methods of artificial propagation have been so perfected and cheapened as to be justified even from the standpoint of the utilitarian ; when the conditions of success in breeding and rearing fish have been so wel established and secured, that we may be sure that the seed sown shall ripen to a productive harvest ; when insurmountable obstructions no longer bar our migratory fishes from access to their spawning grounds or hinder the free circulation of the resident species in our rivers ; when factories no longer discharge their poisonous waste into our rivers, so that they may flow from their mountain sources unpolluted to the sea ; when the modes and apparatus of fishing are so regulated and restrained by law as not to tax too severely natural resources for recuperation and the permanent productiveness of the fisheries is thus established—then the aggressive mission of this society will have, in a measure, ended.

It will still remain for us, by incessant watchfulness, vigilance and surpervision, to conserve the important results which our efforts will have accomplished.

A GLANCE AT BILLINGSGATE.

BY WILLIAM VAN ZANDT COX.

The Thames being the highway to London and originally the source of its fish supply, it was very natural that some point upon it should become the center of the fish trade. Billingsgate has for centuries been that point. As to the origin of both name and market there are many traditions. One is that Belin, an ancient Britain ruler, who lived there three or four centuries B. C. and was held in great reverence by the fisher folk, constructed a gate in the immediate proximity to the present market and gave it his name.

Stow, a very practical writer, after considerable research, comes to the conclusion that a Mr. Beling or Billing, in the time of Elizabeth, had a wharf there. This commencement, though less flavored with romance and more of fish than others, we think more than likely was the beginning of this unpoetical fish mart. The market has been the property of the city of London for centuries, and the revenues derived from it, though no statistics seem to have ever been compiled on the subject, must in the aggregate be enormous.

Originally the market was very primitive, both in structure and equipments—indeed, until within the memory of those still living, it consisted of "a batch of uncleanly old sheds, reeking with fishy smells, and more or less beset by ruffianly company."

The language used by those who frequented it has, as is well known, become proverbial for its coarseness. At one time women were engaged in selling fish in the market, and, it is said, were largely instrumental in giving the place the bad name it bore, and though at this time it has entirely changed from what it once was, it still bears the stigma of coarseness in the minds of many, illustrating, says a clever writer, that "as in the case of men, the evil that women do lives after them."

The old sheds disappeared some years ago, their places being occupied by a building which in turn has given way to the present market. This structure extends north and south from the Thames river to Thames street, and was built with the idea of having not only ground space, but also space in the basement below and the gallery overhead. The basement part was intended for shellfish dealers. But it was not occupied by them long, for being twenty-six feet below the level of the river, it was so dark, damp and disagreeable that few buyers cared to go there. Several deaths also occurred among its occupants, and those remaining being unwilling to stay longer in the "black hole," it was abandoned, except as a place of storage and for lobster-boiling purposes. The overhead space was for dealers in dried fish, and is connected with the ground floor both by spacious stairs and elevators. Being sought, however, by few patrons, it was also abandoned, and its occupants went below and squeezed in, as did the shellfish dealers from the basement, so that at this

time the entire trade is concentrated on the ground floor. Without going into details concerning the architecture of the building, it is sufficient to say that it is generally admitted that the corporation did not act wisely in enlarging the market at a great expense, and in a way that is of no practical use, instead of widening the approaches to it on the Thames street side. The floors of the building are of polished granite, concealed beneath which are drains of iron for carrying off the dirt and refuse when the market is flushed, which is done daily at the close of the market hours.

At the present time there are 156 stalls and fourteen shops on the ground floor. The former are located in the center, while the latter are on the sides of the building. There is also a tavern where fish are served as the leading article of diet. Formerly there were three taverns, Simpson's, Bowle's and Bacon's, where in other days the salesmen congregated before daylight, drank their black coffee and "aff and aff," ate fish and talked over the prices, sales and supply of fish for the coming day. In order to have more space, however, the number of taverns has been reduced to one, which now brings in a rental of $4,000 annually. The stalls vary in size, averaging thirty-two square feet, according to the clerk of the market, Mr. John Little, to whom I am indebted for many courtesies. The stalls, according to location, bring from ten to eighteen cents per square foot per week, or an annual rental from $166 to $300 each. The shops bring from $1,700 to $2,000.

Avenues cross the market at regular intervals, and from necessity are very narrow. Great effort is required to keep them open, and the rules of the market are very explicit in regard to placing obstructions in them. Porters carry the fish into and from the market in baskets, boxes, crates, barrels, in fact, in all kinds of ways. No one is permitted to perform the duties of porter without a license, for which he has to pay 2s. 6d. When on duty, in order to readily distinguish him, the porter is obliged to wear on his left arm a metallic badge having on it the armorial bearing of the city of London. If a porter misbehaves, uses any abusive or obscene language, gets intoxicated, steals, commits assaults or violates any of the rules of the mar-

ket, his license is at once taken from him. I was told that the present conduct of employes in Billingsgate so happily in contrast with "ye olden times," is due to rigid enforcement of rules similar in tenor to those just mentioned.

The porter's dress consists of cotton overalls, a coarse cotton shirt, worn on the outside of the trousers, which from the begrimmed and bespattered appearance are very appropriately called "slops." The head is protected by a "porter's knot," a hat which has a cushion in the crown, very necessarily padding, it might be remarked, as the rough and heavy "trunks" are either borne directly on the top of the head, or resting on the shoulders, back and neck. Wooden sandals are generally worn on the feet to keep the bottoms of the shoes from contact with the sloppy surface. The porter receives on an average about a penny farthing for carrying each box of fish to the salesman. The taking of it from the salesmen to the conveyance of the buyer is an optional charge, depending upon the kinds of fish and distance to be carried.

Land-borne fish enter the building on the Thames street side, while river-borne fish are brought into the market through the south door facing the river. The boats bringing them to London are not permitted to come alongside the building to unload, but, for some reason unknown to me, are required to make fast to fastenings provided for them adjacent to floating pontoons and barges that intervene. Planks, mostly unprotected by side rails, extend from boat to market about a hundred feet distant. Up and down and across these planks the porters tramp with their heavy burdens, for each trunk weighs about 100 pounds.

Nine steam carriers run to and from Billingsgate and the fleets in the North sea, and bring the bulk of the water-borne fish. The unloading of these boats—indeed all kinds of craft—is an interesting sight. But let Sala tell the story: "This wharf is covered with fish, and the scaly things themselves are being landed with prodigious celerity, and in quantities almost as prodigious, from vessels moored in tripple tier before the market. Here are Dutch boats that bring eels, and boats from the North sea that bring lobsters, and boats from Hartlepool, Whitstable, Harwich, Great Grimsby and other English seaports and

fishing stations. They are all called boats, though many are of a size that would render the term ship, or at least vessel, far more applicable. They are mostly square and squat in rigging, and somewhat tubby in build, and have an unmistakably fishy appearance. Nautical terms are mingled with London street vernacular; fresh mackerel competes in odor with pitch and tar; the tight-strained rigging cuts in dark indigo relief against the pale blue sky; the whole is a confusion, slightly dirty, but eminently picturesque; of ropes, spars, baskets, oakum, tarpaulin, fish, canvas trousers, osier baskets, loud voices, trampling feet and 'perfumed gales,' not exactly from 'Araby the blest' but from the holds of the fishing craft."

The method of handling and carrying the fish may strike the author of "Twice Around the Clock" as one of "prodigious celerity," but to an American familiar with steam appliances and labor-saving machinery, it appears to be very tedious, costly and old-fashioned, and in great contrast to systems seen with us, where a vessel puts in, unloads, packs up and leaves the wharf in two hours.

Steam appliances have not been adopted at Billingsgate, I am informed, because the fish would be more rapidly brought to the salesmen than they could be handled, and so the old system is clung to, and porters with trunks on their heads approach the salesman, stand in waiting, then deposit them only as rapidly as they can be sold and again borne away.

The salesman or auctioneer gets five per cent. on the sales made. Many fish were formerly sold at "Dutch auction," where the salesman names a high figure, then drops to a lower one, and so on until a bid is made which is accepted, and the procedure is gone through with *de novo*. No license is required to sell fish by Dutch auction, and this method is still in great favor in many of the fishing ports.

The Bummaree appears to be an individual essential to Billingsgate.

Jonathan Bee, in his slang dictionary ("Lexicon Balatronicum,") published 1823, defines the bummaree to be the man who at Billingsgate takes the place of the salesman, and generally after 8 o'clock A. M., buys the last lot of fish.

The author of "London Labor and London Poor," 1853, says that at that time Billingsgate was opened at 4 A. M., but for two hours it was attended only by the regular fishmonger and the bummaree. At the present time, however, not only is the bummaree the first to arrive, but, as in 1823, he is the last to leave. He now purchases from the salesman and sells to small dealers, costermongers and consumers. Before making a sale, the bummaree breaks the packages and assorts the fish, supplying the buyers with the kinds, sizes and quality desired. A very useful function, it might be remarked when we remember that a "ped" often contains various kinds of fish, suitable and unsuitable for the uses for which they are wanted by different classes of purchasers. But however useful the bummaree may be, that such an individual exists at all, only goes to prove the inadequate accommodations of Billingsgate for the trade, and whether there is foundation or not for such accusations as are heard concerning him, the bummaree will exist so long as the fish supply of populous London has to pass through this limited, inaccessible market in a limited time.

The market is opened at 5 o'clock in the morning and is practically over at 10 o'clock. Before the opening, however, the auctioneers are in their places, behind what are called "bulks" or "forms," upon which the fish are deposited in "trunks," "doubles," etc. Little, if any, opportunity is given buyers to ascertain the condition of the fish, for no sooner is the box deposited on the "bulks" than it is knocked down as sold, and again borne away. If the buyer is not informed in some way in regard to the condition of the fish, to purchase the unopened boxes so rapidly, and with such apparent indiscriminate recklessness, it would seem to an outside observer, to put it mildly, great confidence in the condition of the fish, and in the honesty of the salesman.

During the whirl of business all seems confusion and chaos. Porters are seen rushing hither and thither with reeking barrels, baskets and boxes. Auctioneers with long, narrow account books in their hands, are bawling to buyers, who, with hands by the side of their mouths, direct back their shouting answers, while the uninitiated explorer stands bewildered in their midst

until he is called to his senses by the exclamation, "Hout the way." "The only comparison I can find for the aspect, the sights and sounds of the place," says a well known writer, "is a rush hither and thither at a helter shelter speed, apparently blindly, apparently without motive, but really with a business-like and engrossing pre-occupation for fish and all things fishy. Baskets full of turbot, borne on the shoulders of the facchini of the place, skim through the air with such rapidity that you might take them to be flying fish."

"At that piscatorial bourse," says Bertram ("Harvest of the Sea," p. 59), we can see in the early morning the produce of our most distant seas brought to our greatest seat of population, sure of finding a ready and profitable market. The aldermanic turbot, the tempting sole, the gigantic codfish, the valuable salmon, the cheap sprat and the universal herring, are all to be found in their different seasons in great plenty at Billingsgate and in the lower depths of the market buildings, countless quantities of shellfish of all kinds stored in tubs may be seen, and all over is sprinkled the dripping sea water, and all around we feel that 'ancient and fish-like smell' which is concomitant of such a place."

Commercially speaking, fish are divided by the Londoner into two classes: 1. Prime. 2. Offal. The former comprehend the choice varieties, such as sole, brill, turbot, etc. The latter includes the commoner, coarse kinds, such as place, roker, haddock, etc. The quantities that come into Billingsgate are very disproportionate. Mr. Little says that thirteen boxes of offal reaches the market to one box of prime. That gentleman has very kindly furnished me a table showing the quantity of fish arriving at Billingsgate per month during the year 1883, which I shall make a part of this paper, as also a series of tables showing the amount of fish coming to London since 1875. It will be seen from Mr. Little's statement, that the quantity coming by water is much less than by land. Special trains bearing fish alone run daily to London from Grimsby, Hull, Yarmouth and other places. As these trains do not come in the vicinity of Billingsgate, the fish have to be carted through the narrow streets and tortuous lanes, across the city to the market, in

order to be sold, and when sold to be again carted over the same streets through which it has already with difficulty passed.

Speaking of the approaches to Billingsgate, the *Quarterly Review*, October, 1882, says: "Their badness was of comparatively slight importance, so long as the bulk of the fish was brought thither by water. When, however, it became necessary to deal each year with some 90,000 tons of railway-borne fish, and to deliver them at Billingsgate, through choked streets and narrow lanes which would disgrace a city of 50,000 inhabitants, the difficulties were so augmented that fish vans sometimes took eight hours to get from the Great Eastern or Great Northern railway terminus to the market where they had to unload."

This statement has greater force when it is remembered that the width of the roadway of Lower Thames street, on which the market is situated is but sixteen and a half feet wide. St. Mary-at-hill has a width of sixteen feet, while Botolph lane and Pudding lane are each but seven feet three inches wide.

Language fails to convey to one's mind the bewildered condition of things in the congested approaches to the market, where the stopping of a "shandry," for instance, will block the entire street. It was shown in an investigation made by Spencer Walpole, late H. M. Inspector of Fisheries, that ordinarily it not only took hours for fish vans to reach the market, but in one instance a van of "fresh fish" was eleven days *en route*, and all the time trying to get unloaded. A vast amount of good food is very naturally spoiled before it reaches the market, and afterwards, too, for that matter, simply from the absence of proper appliances for its preservation; and it is not strange that when the fish reach the consumer it is so enhanced in price as to have become a luxury instead of an ordinary article of diet.

The *Times* of October 30, 1883, despondingly asks, "Could not science have fish vaults where the temperature was kept at about thirty-three degrees at the markets? Could not science improve on the ice chests fishmongers use?"

We answer unhesitatingly in the affirmative, and cordially invite the editor of the "*Thunderer*" to visit America and see the fish markets in Boston, New York and other centers, where the

application of scientific methods of refrigeration to the fish trade that have long been in use could be seen.

What London requires in order to have the price of fish reduced and the quality improved, and a cessation from talk about "Billingsgate ring" and "Billingsgate monopoly," is to have a more commodious market—a market with refrigerating appliances, a market on the river side, easily accessible not only for boats, but for cars, vans and all kinds of conveyances.

Thus far it has been impossible to agree upon a new site. If the market has to remain where it now stands, so choked for space and difficult of approach, then if it be desirable to remedy the patent evils, the streets leading to Billingsgate will have to be widened. The postponement of the widening to a more convenient season will not lessen the cost. In 1862 the approaches could have been widened for £88,000, and twelve years afterward the estimated cost was £525,000, and now, doubtless, it would be much more.

In conclusion, I regret to say there is little, if anything, at Billingsgate for American fish dealers to learn, except how far in advance of them in every respect we are on this side of the Atlantic.

RETURN OF THE QUANTITY OF FISH DELIVERED AT BILLINGSGATE MARKET DURING THE YEAR 1883—(JOHN LITTLE, CLERK, BILLINGSGATE).

Month.	Land carriage. Tons.	Water carriage. Tons.	Total. Tons.
January	6,015½	2,949	8,964½
February	5,562¼	1,969	7,531¼
March	6,983¼	2,622	9,605¼
April	6,394	3,911	10,305
May	5,898¾	4,765	10,663¾
June	8,536	4,679	13,215
July	5,400	3,353½	8,753½
August	5,678	3,486	9,164
September	7,104½	4,671	11,775¼
October	6,583¼	2,028	8,611⅜
November	7,401¾	1,984	9,385¾
December	9,166¼	2,529	11,695¼
Total	80,723¼	38,946½	119,669¾

N. B.—There was also from 20,000 to 25,000 tons of fish delivered in the immediate vicinity during the year, which is not included in the above.

The quantity destroyed by the officers of the Fishmongers' Company, as being unfit for food, was 273 tons, 16 cwt., 1 qr., and of this ninety-five tons was composed of shellfish.

APPROXIMATE QUANTITIES OF FISH DELIVERED AT BILLINGSGATE MARKET AND VICINITY, 1875-1884.

(British Fisheries Directory and Mr. Little's Report.)

	Tons.		Tons.
1875	94,949	1880	130,629
1876	99,425	1881	137,000
1877	107,168	1882	150,000
1878	126,764	1883	144,669¾
1879	126,892	1884	156,005

Washington, D. C.

THE OYSTER BEDS OF NEW YORK.

BY EUGENE G. BLACKFORD.

During the past year an investigation has been in progress in the State of New York, under my charge, for the purpose of ascertaining the actual condition of the oyster areas of the State, and to gain some general knowledge of the oyster industry as carried on in our waters.

This work was begun on the supposition that there was danger of a failure in our oyster supplies in the near future, unless some steps were taken toward remedying certain practices and evils which were thought to be detrimental to the success and continuance of the industry. Thus far only a portion of the oyster territory of the State has been examined, and that only superficially; yet the examination has been sufficient to establish two points, one of which shows conclusively the need of such an investigation, and the other that there is no danger of a

failure in the supply of these mollusks for our markets. These two points are, first, that the natural oyster areas of the State are in bad condition and very much less in extent than they were a score or more of years ago, and, second, that the loss in the natural areas has been much more than made up in the formation of planted beds, some of which occupy the localities of natural areas, which have been exhausted of their natural supplies, and have been repopulated by artificial means, and some of which have been formed on territory that never was natural oyster ground, and by reason of this increase in the amount of territory upon which oysters are grown, a great many more oysters are now sent into market each year than were thus shipped some few years ago. This is true to a very large extent of all the oyster regions of our State ; the natural areas have been worked until, in many instances, they have been entirely depleted, and in all cases very much lessened in productiveness ; and then the planters have appropriated the exhausted lands for planting purposes, and extended the planted areas outside of the old bed limits, but some of the oyster regions show much greater changes in this direction than the others. This is perhaps more noted in the neighborhoods of Staten Island and City Island than elsewhere, since these regions are not only close to our great metropolitan markets, and therefore can be drawn upon at short notice, but they have suffered more than the others from the direct action of the refuse materials thrown into the waters from the cities of New York, Brooklyn, Jersey City and their suburbs. This has been a source of great injury, and where formerly many oysters were obtained from along the shores of the lower bay, around the northern end of Staten Island and along the East river, now there are none to be got, or if any can be secured, they are so contaminated with the acids and filth of the waters that they are of no value as food. This is an evil which can only be remedied by careful and consistent legislation regarding the sewerage of the great cities and the disposal of waste matters.

In the neighborhood of City Island there were formerly many large tracts of natural oyster beds, from whence great quantities of fine oysters were obtained ; but as there were no stringent

regulations in regard to the working of the beds, or the protection of the oysters during the breeding season, and no system of guarding the beds, they were gradually despoiled and their places taken by the planted areas ; and the same may be said as regards the lower portion of Staten Island, and in fact, of all portions of our State. To a certain extent, this is an advantage to the oyster industry of the State, and to a certain extent it is a disadvantage. By having these lands brought under the direct influence of individual oystermen, that is, by transforming them from public into private property, they can be better protected than when open to every one, as each individual planter will feel more of an interest in guarding his own land than in guarding the land of the public domain, and they can accordingly be worked in a manner to promote the welfare and continuance of the bed, rather than in such a manner as to exhaust it as quickly as possible.

It is on the principle, of course, that business, in order to be successful, must be personal to those engaged in it, and while this may be largely true as regards the oyster property of the State, yet if the beds are permitted to become exhausted in this manner, and then to be taken up, as they have been in the past, by any one who desires to appropriate this kind of property, it will cut off a great number of people from obtaining seed oysters, and furnish private property to a greater or less number of individuals, without any recompense being given, even to the State, or to those deprived of the privilege of gathering oysters from public beds. It would seem as if it would be better to guard the public beds, and preserve them as seed grounds, and encourage the planters to appropriate land for artificial cultivation that is not suitable for natural growth, enacting suitable laws for the protection and guarding of the natural areas, and for the perpetuity and protection of the planting industry. Many of the oystermen feel at the present time that there is no certainty, from the present condition of the laws, that they will ever gain anything from any improvements they may make, or for any expense that they may be to in fitting up territory which is not now natural bottom, but which might be rendered excellent for plants, and so they do not enter into the work as heart-

ily as they otherwise might do. And in view of the chaotic state of the laws in general, and the peculiar way in which many of them are carried out, it is somewhat to be wondered at that so much has been accomplished in the direction of artificial culture, as has been done. The possibilities in this direction are well illustrated in Jamaica and Hempstead bays, upon the shore of Long Island. In the towns bordering upon these bays, laws have been enacted, under authority from the State, whereby any resident can appropriate three acres or less of land under water, for the purpose of oyster cultivation, and the occupant is protected in his rights and titles to such land, so long as he works the land and pays the rent upon it. The land under water thus becomes practically the same as the land above water, a permanent property of the planter, and is worked just as upland is, to preserve it and yet get as much out of it as possible. The consequence is that where a few years ago only a few oysters were raised for market, to-day the industry represents hundreds of thousands of dollars annually, and can be yet greatly increased by the employment of new methods of getting seed and caring for the growing stock. As it is, it represents the most active and progressive oyster center in our waters.

One great difference between this and other oyster regions is, that here they recognize the value of a thorough working of a small amount of territory, while in other localities the oystermen generally try to get and hold all the territory they can, without any particular regard to how well such territory is worked. Some of the other regions are following to a certain extent in the footsteps of the planters of Jamaica and Hempstead bays, and just in this proportion are they meeting with success. While the industry in the State is, as a whole, in fair condition, so far as regards the number of oysters sent to market, the number being, perhaps, three or four times what it was fifteen years or so ago. It is not what it ought to be or may become, and the future supplies will depend largely upon the care with which the oystermen guard the present seed beds and work their planted territory. The possibilities are great, provided advantage is taken of all improved methods of culture, and some desire is shown to perpetuate rather than destroy the natural areas.

It is to be hoped that the oystermen will cordially co-operate in the work now in progress, and that by means of judicious legislation the natural beds may be preserved and protected, and the industry stimulated and permanency given to it in our waters.

Fulton Market, New York.

THE BIENNIAL SPAWNING OF SALMON.

(The Bucksport Experiments.)

BY CHARLES G. ATKINS.

After the organization of the establishment for the collection of eggs of sea-going salmon at Bucksport, on the Penobscot river, in 1872, it was one of the earliest suggestions of Professor Baird that we should attempt, as occasion might offer, to obtain evidence bearing on the frequency and duration of the salmon's migrations and its rate of growth.

To carry out these suggestions it seemed requisite that observations should be made on individual fishes at successive periods in their lives; yet, whatever means should be taken to secure and identify them must, it was evident, not prevent free movement in the open river to and from the sea, or interfere in any way with the development of their functions or their regular growth. They must be distinctly and durably marked, yet in such a way as to do them no injury. The cutting of the fins would answer the purpose only in part, since it would not afford a sufficient variety in form to enable us to distinguish a great number of individuals. Branding upon the side of the fish was thought of and even tried, but the serious mutilation that befel the first fish operated on, and the extreme probability that those marks that were so lightly impressed as to do no injury to the fish would soon become illegible, or so nearly

so as to be overlooked by fishermen, caused that method to be abandoned. A metallic tag, stamped with a recorded number, appeared to offer the greatest promise of success. The first tag tried was of thin aluminum plate, cut about a half inch long and a quarter wide, and attached to a rubber band which encircled the tail of the fish. It is possible that most of the bands slipped off, and that those which were tight enough to stay on cut through the skin, and produced wounds that destroyed the fish. At any rate, no salmon thus marked were ever recovered.

The next method employed was the attachment of an aluminum tag by means of a platinum wire to the rear margin of the first dorsal fin. This place of attachment was chosen because, being near the middle of the fish, it has less lateral motion when the fish is swimming than any point nearer the head or tail, and because the tag, lying thus in the wake of the fin and close to the back, would be better protected from contact with foreign objects than elsewhere. The attachment was effected by placing the fish upon a narrow table, confining it by straps, and piercing the thin membrane of the fin between the last and next to the last ray, by means of a needle, into the eye of which was threaded the wire already connected with the tag ; the ends of the wire were then twisted together, so as to form a loop, and neatly trimmed with scissors. The tags were stamped with dies. This mode of marking has been adhered to in all subsequent experiments of the kind, with no change except that the aluminum tag has been replaced by one of platinum.

The marking was always done in the fall, after the fish had been relieved of their spawn. They were then liberated, either in tide water or in fresh water whence egress to the sea was easy.

Of the salmon marked with rubber bands in 1872, as has been said, none were recovered. In November, 1873, there were marked 391 salmon. In the ensuing year rewards were offered to the fishermen for the return of any marked specimens. In response, there were sent in to the station twenty salmon, the first in January (taken in a smelt net), and all the others in April and May. All of the twenty retained the wire, by which they were with certainty recognized as having been marked in the preced-

ing autumn. Sixteen of them still retained the tags. One of them was found to have lost eight ounces in weight, eight others had lost from one to two pounds each; all had fallen away in flesh since November. The males had faded in color; the hooks on their lower jaws were still present, but had decreased much in size. The females had regained their bright silvery color to a great extent; in their ovaries were the germs of the next litter of eggs, but they were very small. No food could be found in the stomachs of either sex. It was quite evident from their condition that these fishes could not have been to their feeding grounds during the winter. Twelve out of the twenty were taken in the Penobscot above Bucksport, and nine of these were taken at Veazie, twenty-five miles above Bucksport, in close proximity to the first serious obstacle they would encounter in ascending the river. Salmon in their condition should be bound toward the sea, and had they, as may have been the case with some, reached the upper waters, it is quite impossible that they could have become breeders the same year. That all these loiterers dropped down to the sea before the first of June, we may conclude from the fact that after that date no more were captured. During the whole year not a single marked fish was recovered or reported, that had in any degree mended from the condition in which it was released the preceding autumn.

In 1875 the offer of a reward was renewed, and this time resulted in the recovery, in May and June, of eight specimens, and among our breeding fish there was found in the autumn another whose mark had escaped observation at the time of capture. Of these nine fish, four were females, three males, and two not determined. They were all of good size, weighing from sixteen to twenty-four and a quarter pounds, and measuring thirty-four and a half to forty and a half inches in length, and were all fat and apparently healthy. One of the females was placed alive in our inclosure and yielded in the fall about 11,500 eggs. Unfortunately, the tags, supposed to have been good aluminum plate, proved deficient in durable properties, became (as we learned by direct observation) weak and brittle after a short time in water. All of them had fallen off from these

specimens, and we could not therefore trace the record of the individual salmon, but the wire remained and proved beyond question that these salmon were marked and released in November, 1873, as none others had up to this time been marked in the same manner, and none at all marked in 1874. They had thus been absent eighteen or nineteen months, and had (we cannot doubt) passed the intervening months, including the summer of 1874, mainly on their feeding grounds in the sea. The experiment was repeated in 1875 and in 1880, with platinum tags, which proved durable.

In 1875 there were marked and released in tide water, at Bucksport, 357 salmon. In the spring of 1876 a considerable number of these were taken in the river; but without exception they were, as in 1874, all poor. In 1877 three specimens were recovered, all in good condition and of larger size than when released. The first, No. 1019, was caught on Cape Gellison in April. This was a female fish; before spawning it weighed twenty-one pounds six ounces, and at time of release sixteen pounds. When retaken, seventeen months later, it weighed thirty-three and a half pounds. The second individual, No. 1,010, was also a female; weighed before spawning eighteen pounds two ounces, after spawning thirteen pounds eight ounces, and on recapture in Lincolnville, nineteen months later thirty pounds eight ounces. The third individual was also a female; weighed twenty pounds seven ounces before spawning fifteen pounds on release, and twenty-six pounds on recapture in Lincolnville, nineteen months later. The results of this second experiment supported the conclusions drawn from those of the first in every particular.

The salmon marked in 1880, numbering 252, were released in the fresh waters of Eastern river, a small branch of the Penobscot. The distance from the point of liberation to tide-water was two miles, and the only impediment a dam over which they could easily go down in the spring, or at any high water when the river was not very low, but which during the winter must have constituted a serious impediment. There is reason for thinking that the larger part of these salmon remained above the dam until the spring floods. A small reward was offered

for the return of fish or tags taken the next spring, and twelve tags were received. Nine of the fish bearing them were weighed and found in every instance to have fallen away in weight since marking. No fully or partially mended fish were obtained or heard of that year. But in June, 1882, five prime salmon were recovered bearing the tags affixed in October and November, 1880. The following statement shows the date for each individual :

RECORD OF MARKING.

No.	Date. 1880.	Sex.	Length inches.	Weight before spawning. lbs.	oz.	Weight of eggs. lbs.	oz.	Weight on release. lbs.	oz.
1135	Oct. 28	F.	30	9	7	1	15	7	8
1136	Oct. 28	F.	30	9	5	2	1	7	4
1239	Nov. 5	F.	36	17	12	3	8	14	8
1248	Nov. 5	F.	32	10	5	2	5	8	0
1247	Nov. 12	M.	30½					8	8

RECORD OF RECAPTURE.

	Date. 1882.	Place.	Length inches.	Weight. lbs.	oz.
1135	June 20	Bucksport Center.	34½	16	8
1136	June —	Searsport.	35½	17	4
1239	June 22	Sandy Point.	39¼	21	0
1248	June 27	North Bucksport.	39	21	0
1274	June 23	Frankfort.	—	14	12

The results of this third experiment coincide, it will be seen, with those of the other two, and they leave little room for doubt that it is the normal habit of the Penobscot salmon to spawn every second year. Had any considerable number of them recovered condition in season to return to the river for spawning the year after their first capture, they would hardly have escaped detection altogether ; indeed, they would have been much more likely to retain their tags, since they would have borne them only six or seven months, instead of eighteen or nineteen. This view is further supported by what we know of the reduced condition in which the end of the spawning season finds the salmon, the short time, only six months, that intervenes between the spawning season and the time for the next "run" up the river, the low temperature then prevailing in the river and bay, and the fact, which is pretty well established, that a large part, perhaps nearly all the salmon, instead of proceeding at once to sea

after spawning, linger in the fresh water all the winter, and descend only with the spring floods. *Bucksport, Me.*

WORK AT COLD SPRING HARBOR.

BY FRED MATHER.

In this paper will be given merely a glance at the work done at the hatchery, under my care, on Long Island, during the season of 1884–85. The place is leased, and most of the work done, by the New York Fish Commission, although the United States Commission on Fisheries has considerable work done there. In the fresh-water department we can report:

A. SHAD.—On May 20, 1884, I received 80,000 shad eggs from Washington, in compliance with my request to be allowed to experiment with them in spring water. They were placed in the McDonald jars, and on May 29, there were planted in the Nissequoge river, at Smithtown, Long Island, 72,000 fry. This seems to have been the first trial of hatching this fish in spring water, and as Col. M. McDonald wrote me that the success privately reported might revolutionize present methods, I will give the details in full:

[May 20, received 80,000 eggs at 6:20 P. M., put them in the jars at 7:30 P. M. Temperature of water 58° Fahr.; of eggs, 55°. Eggs began hatching May 24, finished May 27.]

Date.	Temp. of water.	Loss of eggs.	Loss of fry.
May 21	60	30	....
May 22	59	45	....
May 23	60	60	....
May 24	71	40	125
May 25	62	25	20
May 26	60	20	42
May 27	58	15	800
May 28	59	....	150
May 29	60	....	40
		235	
Dead on unpacking		380	
		615	1,177
Total loss			1,792.

A similar trial made later proved a failure.

From the preceding table of losses and the figures given as planted, it will be seen that there is a discrepancy of only 208 fish, and these are on my side. Further, my estimate of eggs received exceeds that of Col. McDonald by about 5,000. The cool spring water, say of about 60 degrees (the mean of the above table is 60.7 degrees), seems to account for the absence of fungus on the dead eggs. Having hatched shad eggs in iced water (see Report U. S. Fish Commissioner for 1873, '74 and '75, pp. 372, 376), and on the rivers of the Atlantic coast from the Pamunky to the Connecticut, where it has often reached eighty degrees, I find spring water at about sixty degrees to be the best medium for shad eggs which I have used. In the summer of 1884, I made an examination of the shad fisheries of the Hudson for the New York Fishery Commission to find the best place to take eggs. There are several points on the river where eggs can be obtained, and these lie between Kingston and Hudson. The catch of fish during the season of 1884 was a very fair one, owing, no doubt, to the plantings by the State and by the U. S Fish Commission.

B. Brown Trout.—On Feb. 24, 1885, we received from the Deutschen Fischerei Verein a box of 40,000 eggs of the brown trout (*Salmo fario*), half of which were billed to Mr. E. G. Blackford, and the remainder to me. The loss in transit was 1,020, and we afterward lost 2,594 eggs and 8,131 fry ; 28,900, according to our estimate, were planted in Queens, Suffolk, Westchester and Rockland counties, N. Y. These fish are destined to become great favorites, and the demand for them increases.

C. Brook Trout.—We received 7,000 eggs from the United States Fish Commission at Northville, Mich., Frank N. Clark, superintendent, and a lot of Rangely and blueback trout eggs from the Maine Fish Commission, on account of Mr. Francis H. Weeks, of Cold Spring Harbor, but which were so arranged that we could not tell which was which, and no careful estimate of the number was made, as a mistake occurred in shipping ; probably there were 50,000 in all. These, together with some 16,000 eggs taken from our pounds, were hatched and distributed on Long Island.

D. Rainbow Trout.—From 20,000 eggs received from the

United States Fish Commission, Northville, Mich., we hatched and distributed 14,500 in Kings, Queens, Westchester, Suffolk and Rockland counties, N. Y.

E. Salmon (Penobscot).—From 500,000 eggs received from the United States Fish Commission station at Bucksport, Maine, Mr. Chas. G. Atkins, superintendent, we planted 269,300 in the tributaries of the Hudson, in Warren county; 99,350 in the tributaries of the Delaware, in New Jersey; 46,000 in the Oswego river, and 4,900 on Long Island. The success of former plants in the Hudson is announced by Mr. A. N. Cheney, of Glens Falls, N. Y., who says they are plenty in Clendon brook, and promises specimens.

F. Land-Locked Salmon.—Of 60,000 eggs of the land-locked salmon presented to the State by the United States Fish Commission, only 16,300 fry were distributed, owing to their being retarded in troughs too long awaiting orders. The fish were assigned to Adirondack waters, but for lack of orders were finally distributed on Long Island.

G. Whitefish.—We have favorable reports from former plantings of whitefish on Long Island, but lack specimens, and therefore have no proof that they have lived. From one million eggs we distributed 990,000 fry as follows: 600,000 in Great pond, near Riverhead (where success was reported); 340,000 in Lake Ronkonkoma, and 50,000 in St. John's lake, Cold Spring Harbor.

H. Smelt.—The result of experiments with these refractory eggs will be found in another paper read before the society yesterday, and there is nothing new to add.

SALT-WATER DEPARTMENT.

A. Codfish.—Owing to bad weather and perhaps other causes, no good eggs of the cod were taken. There has been no decided success in the hatching of this fish, although a few have been hatched by Capt. H. C. Chester and Prof. J. H. Rider, both of the United States Fish Commission. This fall we hope to have a smack come in to the station with live cod, and try to obtain good eggs.

B. Tom-Cod.—With these eggs we have good results. We took 280,000, and turned loose 213,000 fish. The eggs are not adhesive like the smelt's, nor buoyant like the cod's. These hatched in about twenty-five days.'

This record shows that between two and three million eggs were placed in the troughs at this station, and besides this there were over 3,000 more handled and repacked for foreign shipment, or received from foreign countries for hatcheries in America, all the foreign receipts and shipments passing through my hands for inspection or repacking, in which great successes have been scored. We propose to begin the artificial culture of oysters this summer.

Cold Spring Harbor, Suffolk Co., N. Y.

THE RIVER EXCURSION.

On Thursday, May 7th, the society made a trip to the shad hatching grounds of the Potomac on the U. S. Commission steamer *Fish Hawk*, by invitation of Prof. S. F. Baird. Col. Marshall McDonald acted as master of ceremonies, and was ably assisted in doing the honors by Lieut. Pietmeyer, Prof. Goode and Mr. Cox.

Arriving at Fort Washington, an attendant showed four million eggs in process of packing for shipment to the central station at Washington. At 3 P. M. the company sat down to a lunch of planked shad, corn bread and coffee, and then made ready to return. On the homeward trip a meeting of the Executive Committee was held in the cabin, Hon. Theodore Lyman presiding. Mr. Lyman suggested that the present was a proper time to transact any unfinished business, and to make any necessary arrangements for the next meeting.

Prof. Goode moved that a vote of thanks be tendered to Prof. Spencer F. Baird, Commissioner of Fisheries for the United States, for his courtesy in placing the *Fish Hawk* at the disposal of the society for this trip. Carried.

Mr. Clark moved that the next annual meeting of the society

be held in Chicago. He said that it would be a great gain in the membership to the society to hold it there, for many Western men had held aloof from it, thinking it to be an Eastern society entirely, and that little or no attention was paid to Western fisheries.

Prof. GOODE.—The remarks of Mr. Clark carry great weight. It is desirable to meet in other places than New York and Washington, although the latter is common ground. I think it would be well to meet in Chicago next year.

Dr. HUDSON.—In 1876 we met in Philadelphia, but did not gain any members to speak of, yet if it is believed to be the best to meet in Chicago, we might try the experiment.

Mr. MATHER.—If it is necessary to meet at different points to avoid the charge of localism, it may be well to do so. But why any person should consider that the society is in any sense a local one I fail to see. Its name covers the continent, and the subjects treated of are not at all restricted to any locality. It has been suggested, and I thought it understood, that the next meeting should be in New England, perhaps in Boston, and we certainly should meet there some time, if we propose to change about. New York and Boston are the great fish centers, and Washington, as Prof. Goode has said, is common ground. I do not think that any place is as good as Washington, but will agree to anything the majority think best.

Mr. BUTLER.—If we go West one year, we will not lose members, but will gain them. The Commissioner of Agriculture hoped that we would go west of the Mississippi, and if so we would have a large meeting ; but at Chicago we would certainly have a most interesting and profitable one.

Mr. MAY.—I hope that this question will be decided to-day, and that it will be in favor of Chicago. We will then begin to urge Western commissioners, and those interested in fish-culture and in fishing to attend.

Mr. CLARK moved that the next meeting be held in Chicago, and that a local committee be appointed to fix the date and make all necessary arrangements. Carried.

The President appointed as such committee, Messrs. F. N. Clark, W. L. May, Dr. R. O. Sweeney, A. P. Butler, Fred Mather and W. V. Cox. The meeting then adjourned.

TREASURER'S REPORT.

DR. EUGENE G. BLACKFORD, Treas. in account with AMERICAN FISHERIES SOCIETY. CR.

1885.				1884.		
May 12th,	To amount of annual dues collected during past year, - -	$147 00		May 15th,	By bill omnibus fare for members attending White House reception, - - - - -	$10 00
	To balance from last year, -	205 75		May 15th,	By cash paid messenger, -	60
	To " due Treasurer, - -	102 58		" 15th,	" " " telegrams, - -	40
				" 15th,	" " " Fred Mather, (telegram), - - - - -	25
				May 15th,	By cash paid Fred Mather, (telegram), - - - - -	50
				May 15th,	By cash paid Fred Mather (postage), - - - - -	12
				May 19th,	By cash paid for account book, -	50
				June 6th,	" " " R. J. Geer, stenographer, - - -	78 12
				June 6th,	By cash paid Col. M. McDonald postage, - - - - -	3 00
				July 10th,	By cash paid W. V. Cox, expenses of meeting, - - -	37 40
				Nov. 10th,	By cash for postage on reports,	7 50
				Dec. 1st,	" " " type-writing, - -	4 00
				" 3rd,	" " " J. M. Davis for printing reports, notices, bills, &c.,	312 94
						$455 33
		$455 33			Balance due Treasurer, - -	$102 58

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AMERICAN FISHERIES SOCIETY.

1886.

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TRANSACTIONS

—OF THE—

American

Fisheries Society

Fifteenth Annual Meeting.

HELD AT THE

PALMER HOUSE, CHICAGO, ILL.

April 13th and 14th, 1886.

New York.

1886.

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CONSTITUTION.

The following is the Constitution, as revised and accepted after the report of the committee, which was appointed at the last meeting, had been by sections.

ARTICLE I.—Name and Objects.

The name of this Society shall be "The American Fisheries Society." Its object shall be to promote the cause of fish-culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of the interests of fish-culture and the fisheries; and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II.—Members.

Any person shall, upon a two-thirds vote and the payment of three dollars, become a member of this Society. In case members do not pay their fees, which shall be three dollars per year, after the first year, and are delinquent for two years, they shall be notified by the Treasurer, and if the amount due is not paid within a month thereafter, they shall be, without further notice, dropped from the roll of membership. Any person can be made an honorary or a corresponding member upon a two-thirds vote of the members present at any regular meeting.

ARTICLE III.—Officers.

The officers of this Society shall be a President and a Vice-President, who shall be ineligible for election to the same offices until a year after the expiration of their terms, a Corresponding Secretary, a Recording

Secretary, a Treasurer, and a Executive Committee of seven, which with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session four to constitute a quorum.

ARTICLE IV.—Meetings.

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or in default of such action, by the Executive Committee,

ARTICLE V.—Changing the Constitution.

The Constitution of the Society may be amended, altered or repealed, by a two thirds vote of the members present at any regular meeting, provided, at least fifteen members are present at the said meeting.

Fifteenth Annual Meeting

—of the—

American Fisheries Society.

FIRST DAY.

Tuesday, April 13th, 1886.

The Convention was called to order by Dr. William M. Hudson, the Vice-President, in the chair, at 11 o'clock A. M.

The Chairman.—Gentlemen, in the absence of Col. McDonald, the President of the Society, it devolves upon me to preside over this meeting to-day. Inasmuch as we are deprived of his presence by reason of a sudden death in his family, I would say I have not prepared any opening remarks. I can simply say that in this first meeeting in the West, I sincerely trust we may make up in quality what we apparently so far lack in numbers.

I notice, gentlemen, that in accordance with the course of our previous meetings, we have first to consider routine business, which will come up in its regular order, and I would ask the Secretary for any suggestions which he may have to offer in regard to this matter.

Secretary Mather.—Mr. President, the usual routine business of the opening of the meetings has been the appointing of committees, and one of those committees, the most important I

believe, to be a committee for nomination of officers, which should report to-morrow. At the last meeting of the association there was a committee appointed to revise the Constitution of the Society. They did revise it and presented a draft of it, which is published in the beginning of last year's report, and it was decided to submit it to this meeting. Whether that will be considered in this morning's session or not is for the members to decide. Then there will be a committee, probably to decide upon the time and place of the next meeting, unless the association should see fit to go into a committee of the whole upon that subject, before we make our final adjournment on the last day of this Convention.

Mr. MAY.—If it is in order, I would move the appointment of a committee of five upon nomination of officers for the coming year. This being duly seconded was carried.

The CHAIRMAN.—Being comparatively unfamiliar with the names and faces of many of those who are present, it would be perhaps rather difficult for me to name five men here now without consultation, and I think we had best wait until the afternoon.

Secretary MATHER.—Mr. President, as you ask me about the order of business, I would suggest that members having papers in their possession to be read, should give the titles of them, in order that we may form some idea of the length of our programme, and of the order in which the papers should be read

Mr. CLARK.—I notice that Mr. Mather says "members." Now, to put matters right here—really I don't know that the local committee of arrangements were authorized exactly what to do in regard to that—I think the invitation has gone out to members and others. We took it upon ourselves to do that, and we have done it, and I would like to say, as chairman of that meeting, that unless there is objection to it, I would like to have that idea carried out, and make it open to all.

Secretary MATHER.—If any gentleman interested in the fisheries wishes to send a paper to be read, I certainly should be

the last man to object to it; we have have never confined communications to members. I would simply say if any gentlemen wishes to send in a paper, I would like to have the title of it in order that we may cut out our work.

The CHAIRMAN.—We shall be glad to see or hear anybody who may be interested in this subject, and it is possible that any gentleman who may be sufficiently interested to have prepared a paper may desire to join this Society.

Mr. CLARK.—I would ask, if it is in order, to present names now for membership.

The CHAIRMAN.—Certainly; that is always in order.

The Convention then went into a committee of the whole on applications for membership, and the following gentlemen were nominated, and duly elected:

Dr. S. C. Adams, Peoria, Illinois; S. P. Bartlett, Quincy, Illinois; J. H. Bissell, Detroit, Michigan; A. Booth, Chicago, Illinois J. N. Dewey, Toledo, Ohio; Philo Dunning, Madison, Wisconsin; N. K. Fairbank, Chicago, Illinois; C. C. Hinchman, Detroit, Michigan; Dr. E. S. Holmes, Grand Rapids, Michigan; Walter D. Marks, Paris, Michigan; James Nevin, Madison, Wisconsin; Dr. R. O. Sweeney, St. Paul, Minnesota; W. D. Tomlin, Duluth, Minnesota; Herschel Whitaker, Detroit, Michigan.

The CHAIRMAN.—I would state that in the absence of Mr. Blackford, our Treasurer, Mr. Mather will act as Treasurer, and has the necessary blank forms of receipt for membership.

Secretary MATHER.—Mr. Chairman, I have here a letter directed to William A. Butler, Esq., of the Committee of American Fisheries Society, from Dr. E. C. Stearns, in which he says he will have a paper on "Intentional and Accidental Distribution of Fishes."

I also have a paper on "The Michigan Grayling," by Mr. Herschel Whitaker. Those are the only papers I know of, except three which I have prepared, the titles of which are "Smelt Hatching," "Oyster Culture" and "Fish-cultural Work at Cold

Spring Harbor, Long Island." As I now fondly gaze upon some of the members here, I feel a little ashamed of myself for writing three papers when they have not written any.

Mr. CLARK.—Mr. Chairman, I would suggest that as Mr. Bissell has a paper, the title of which is "Fish Culture—a Practical Art," I would like to ask if it is a part of these deliberations, that they may be open to discussion?

The CHAIRMAN.—It is always our custom whenever a paper is read, to announce that it is open for discussion by the Society. It has also been the custom of the Society to listen to any matters which are germane to its ordinary scope and its interests at any time after the regular papers are completed, and the more discussion of that kind we have, the better; and, as I said before, in regard to each paper that is read, it is always pleasant for the Society, and generally interesting and profitable, to hear discussions from those who may have knowledge of the subject, and we sincerely hope that the custom may be carried out at this time, and that we may have the benefit of the same work at this meeting that we have had at previous ones.

Mr. BISSELL.—Mr. Chairman, in respect to the fisheries in the West, during the year 1885, if the Society wishes to have that presented, or any part of it, it can be done at any time when it is proper to discuss it.

The CHAIRMAN.—I think the Society would be very much pleased to hear a paper of that kind, and it would come in very properly with the discussion in regard to the fisheries on the lakes.

Mr. BARTLETT.—I feel interested in that matter for this reason: Illinois has never done anything toward re-stocking the great lakes. The fisheries, so far as Lake Michigan is concerned, are practically depleted of white-fish, and if there could be only one particular branch of that subject discussed, I would like to have the white-fish given the most prominent place. I will go to work and prepare a paper on it of five or six lines, if it is necessary, before the close of the meeting.

The CHAIRMAN.—The Chair will state that no question will

be more thoroughly discussed than that of white-fish. There are great States bordering on the lakes, and I am sure it will be exceedingly interesting to hear whatever may be said on that subject.

Whereupon, on motion, duly seconded, the Convention adjourned until 2:30 o'clock P. M.

AFTERNOON SESSION.

TUESDAY, APRIL 13th, 1886, 2:30 o'clock P. M.

The Convention was called to order by the Vice-President, Dr. Hudson.

Mr. PHILO DUNNING.—Mr. Chairman, I would like to inquire what constitutes a member of this Society?

The CHAIRMAN.—All that is necessary for a man to become a member is to have his name presented at one of the regular meetings, to be elected by the members present, and to pay the annual fee of three dollars, for which he receives the annual report of the Society, and his name remains upon the records; he also receives the notices of all kinds which may be issued in connection with the Society.

The first business of the meeting will be the appointment of the nominating committee, which will report to-morrow morning. The Chair would nominate Mr. May, of Nebraska, Mr. Butler, of Michigan, Mr. Bartlett, of Illinois, Dr. Sweeney, of Minnesota and Mr. Dunning, of Wisconsin.

The Chair would state, also, that we have information that other papers which have not yet been received will be here in time for to-morrow's meeting, and such papers as are ready can be read this afternoon, and a discussion had upon them after the reading, and then we may adjourn until to-morrow, when we probably shall have a larger number present, and at the same time have more papers than we have had time to read to-day. The reading of papers is now in order, unless some gentleman has other business to propose.

The first paper which will be read will be on "The Hatching of Smelts," by Mr. Mather.

Mr. MATHER.—I would state that my first experiments in regard to the smelt appeared in the report of last year, and that very little has ever been done in smelt hatching. Professor Rice and Mr. Atkins have both made some experiments, but not on a large scale. Both succeeded to a limited extent, as I have. This year we had between two and three millions of eggs and may possibly be able to turn out a million of young fish.

SMELT HATCHING.

BY FRED MATHER.

At the last meeting of this Society I read a paper on "Hatching Smelt," giving the details of my first experiments, and stating at the same time that but little had been done with the eggs of this fish and that the literature of its culture was very limited. I have continued these experiments the present year and have but little to add to what I have before said. The eggs of the smelt are the most unsatisfactory of any fish eggs I have ever handled. Their glutinous character and small size forbids the separation of the dead from the living by the automatic jars or by hand picking, consequently they decay and become foul.

We have this year at the Cold Spring Harbor station of the

New York Fish Commission placed them upon the straw coverings of wine bottles, hung in ponds, and also placed them in the hatchery in running water. Others were put on tin pans hung in the ponds and the McDonald jars, under several different conditions; one of these was to place the newly taken eggs in jars and by slowly rotating it to leave a covering of eggs all around the inside. Another mode was to put them into jars and give them a strong circulation of water to prevent their adhering in masses as much as possible. The third method was to give a jar a very slight circulation and let them mass together.

The eggs exposed to light on the straw and tin pans in the open ponds out of doors, were soon covered with fungus and did the worst of all, although a few hatched.

The first eggs obtained this year were taken on February 25th, to the number of 400,000. Some of these were placed upon the straw coverings, referred to above, and others were put in jars, the main portion being thus deposited. Both these lots began to hatch on April 5th, forty days after, and when I last saw them on April 9th, there were perhaps 10,000 already hatched; while the other eggs, taken on the same day and subjected to the same treatment, looked as though they would not hatch for four or five days yet. At this same date (April 9th) a lot of eggs taken on March 6th, nine days after the former lot, had already begun hatching. This seems to be a very wide margin of time for eggs which only take from thirty to forty days to hatch. The time occupied in hatching this year exceeds that of last season, on account of the severe cold weather we have had throughout March. The eggs which were taken in thin layers on the inside of the glass jars by rotating, as above described, have done very badly. The others are doing fairly well for smelt eggs.

I sent Mr. F. N. Clark some eggs this year, cautioning him not to throw them away, no matter how bad they looked on the outside, how much fungus there might be there, nor how foul an odor might arise from them. At the same time I had fears that he might do this; for in our experiments we had found that the decaying eggs on the outside masses were so foul, that nothing but previous experience could have convinced us

that any good could have come from the inside of such a mass.

After looking the eggs over carefully, I came to the conclusion that it was a possible thing that the outside eggs died because they were exposed to the light, and made an attempt to get more in order to test this theory, but we were unable to obtain them. I had arranged to divide the next lot of eggs into two portions, putting both into jars which were covered to exclude the light, and give one a strong and the other a feeble circulation of water to test this method, which I shall do next year if the opportunity offers, for so far, our work with smelt has not proved completely satisfactory. We can hatch forty or fifty per cent., and as each little adult smelt has from thirty to forty thousand eggs, we actually get a great number of young fish, but we don't begin to get the percentages of fry that we do in operating with the salmon, the trout and the whitefish. I believe that we will reach this result by continued experiment; and it is one of those interesting questions which stimulate a worker to try and discover the cause of this great mortality.

When we remember the fact that a smelt goes up in swift brooks and deposits its eggs on stones, it is hard to believe that the eggs require a feeble circulation, as was suggested by my friend, the late Professor Rice. I have never had the opportunity to examine a stream after the smelt had finished spawning, and see how the eggs are deposited in a state of nature. But the very fact that a little fish bears such a great quantity of eggs within it, shows that nature has provided for a great loss at some portion of the life of the young, either in the egg or afterward. Their exceedingly minute size when hatched, perhaps a quarter of an inch in length and the diameter of a thread of No. 36 sewing cotton, renders them subject to be preyed upon by exceedingly small fishes, and an ordinary brook trout, when first beginning to feed, could probably accommodate half a dozen young smelts just from the egg in its stomach without inconvenience to itself. The young can swim as soon as they are hatched, and we confine them with brass wire cloth, No. 30 mesh.

Mr. Carman, who supplies me with smelts from Brookhaven, L. I., wrote on April 3rd that he had taken a few more spawners,

the last of the season, and we sent for them immediately; but before the arrival of the can, the fish had spawned, therefore we can place the extreme limits of their spawning season on his stream, this year at February 25th and April 3rd. Some two weeks before the first-mentioned date, Mr. Blackford obtained some smelts from Long Island which were full of spawn, and I sent a man down there for more, but we failed to get any that were ripe. The fish which came to market had eggs extruding from their dead bodies; probably caused by handling and the jolting of the railway on their journey to the market. It is proposed this year, at the suggestion of Gen. R. U. Sherman, of the New York Commission, to plant a few in the Adirondack waters and see if they cannot be established there, as they have been in the fresh waters of Vermont; and the result of this experiment will be watched with great interest.

I have spoken of the egg of the smelt as "glutinous," but 'adhesive" would be a better term. On one side of the egg there is a filmy appendage which is the means of attachment to whatever it comes in contact with, and under the microscope it appears like an empty egg shell folded over and attached to one side of the egg only, while the other side is clean and round.

Cold Spring Harbor, N. Y.

Mr. CLARK.—Mr. Chairman, I would say in regard to the eggs that Mr. Mather sent me at Northville, that I found them in just the condition that he said I probably would. The first glance would give to a fish culturist the idea that of course they were all bad; but upon further examination, when you dig into them, you find that there is a small percentage of them that are good. I should say of those eggs that were sent to us about 15 to 20 per cent. were good. While Mr. Mather was reading his paper, a thought occurred to me, and in the recital of his different experiments I listened to hear him say that he had tried one way, which he did not. About seven years ago, I think it was, I was at Gloucester, Mass., at the first time they were handling the cod for the United States Fish Commission. Among the other experiments which Professor Baird tried was that of taking eggs of the Labrador herring, which are adhesive. They stick solid,

and I tried a great many different experiments in taking eggs, and one of the ways was taking them on glass, which I found to be the best; and I think if a person is going to take adhesive eggs of any kind and let them stick to anything, he will find glass the best of anything. At that time I made a box for hatching on glass. It was a small trough, with places in the side for the glass to slide down. One glass went to the bottom and the top was half an inch under water. The next glass stood half an inch above the water like that, so on down through, keeping the eggs that adhered to the glass on the side toward the water, so that the water passed up right by the eggs, and in that way we succeeded in hatching a better percentage than in any other way. I should think it would be well to try experiments with the smelt the same as they do with the wall-eyed pike, which I think Mr. Nevins and others have tried. I have, and I think the Michigan Commission has tried the same thing.

Mr. MATHER.—Mr. President, I would say in connection with what Mr. Clark has said, that I had read very carefully his experiments with the herring, and thought that his arrangement of glass slides was an excellent thing. As I understand it, that is for hatching in troughs, we have put them on the inside of a jar, as I have described, keeping them whirling and letting them adhere on a thin layer, I have now a theory, which of course remains to be proved, that it is the light that is fatal, because we find where those eggs adhere in masses, perhaps the size of a hickory nut or larger, that all the outside eggs become bad after a while and are covered with fungus, but you take hold of this mass and break it open and you will find the little fellow inside there all right, protected not only from the action of the light, but from the water. I don't understand how water can get into this mass. If I had been going to hatch them in troughs I should certainly have used the apparatus that Mr. Clark devised, and which I think is an exceedingly good thing for that mode of hatching.

Mr. BISSELL.—I would like to say a word about that smelt business. If it is the light that affects the eggs of the smelt, would not the light affect them in their natural condition in a

small stream? May it not rather, or more likely be, the motion of the water? I have been told by our men in the Michigan Fish Commission that one of the reasons that brook trout eggs cannot be handled successfully in the jars, is that they have too much motion. Mr. Marks told me the other day when I proposed that during the first stages of handling the trout eggs they might be put into the jars and run in great numbers, and then as the bad eggs were worked off, place them on trays and hatch them there—he said no, that would not answer, because if they had too violent a motion of the water it would addle the eggs. He said that had been proved by experiment. It seems to me that is much more likely to be the cause of it than the action of the light, particularly at the season of the year when the eggs are cast.

Mr. MATHER.—As regards brook trout in jars, no doubt the violent motion would be injurious to them, but where you have a little stop-cock you can turn that, and you can give them as much or as little motion as you like, and you can have a flow. The trouble in hatching trout in jars begins after you have got them hatched; they lie down in masses on each other and smother.

Mr. CLARK.—Yes, but the jar is not the thing for handling brook trout.

Mr. BISSELL.—You must have a good strong current in order to carry them up and float them in the jars.

Mr. MATHER.—With regard to the smelt eggs, I have never seen the natural stream after the smelt eggs were deposited by the fish. I have been on the ground before the hatching season began, and have seen them take smelts in very swift water, and it is a possible thing that the smelt eggs that are taken and adhere to the top of the stones die, while those which get into the crevices may escape. I don't state it as a fact; I simply state it as a possible thing. They do spawn in tolerably swift water. That I know, for I know the streams where they spawn.

Mr. BISSELL.—Are they shallow streams?

Mr. MATHER.—Quite shallow and running over stones. I have seen them in New Jersey pretty well up on the Hackensack River, and I have seen them at Locust Valley on Long Island where they take them, and they are both rapid streams. The stream at Locust Valley is a trout stream, very swift, running very rapid, and the eggs which we took last year on stones and placed in our hatching troughs, where we hatch the brook trout eggs, all came to nothing—that is those in a single layer, but where there were four or five deep we could pick off the top layer of bad eggs and find them good underneath.

Mr. CLARK.—I would like to ask Mr. Mather a question. What percentage did I understand you to say—that you had forty to fifty per cent. good eggs?

Mr. MATHER.—That is about what we have now.

Mr. CLARK.—Well, Mr. Chairman, I don't think with any adhesive eggs that were ever hatched, where you leave them to adhere, I don't think there is anybody ever hatched anything better than forty or fifty per cent. of any kind, and I don't think they ever will. We don't with the herring, and we call it good.

Dr. SWEENEY.—It seems to me that from all the eggs that are supplied in the spawning of these fish whose eggs are glutinous or adhesive, there is a provision of nature that the outer layer of the eggs act as a protective coat to the inner mass, and as the gas permeates through the tissues and the air reaches the eggs on the principle of displacement—as the internal layer of eggs consumes the air, it is resupplied from the outside, and this putrid mass of eggs on the outside which seems so unproductive, may be in part as a defense also against animals, and is not the experience of Mr. Mather going to show that these eggs that seem to be spoiled on the outside, work no detriment to those within. That may be the principle, that the adhering mass of eggs is a protective coat to the inner stratum. It may be the explanation that the gas or vitalized air from the water reaches the eggs through the outer stratum.

DEEP SEA DREDGING ON THE U. S. STEAMER "ALBATROSS."

BY F. L. WASHBURN.

Though the appropriateness of discussing the above subject in the Society of American Fisheries might at first be questioned, second thought assures me that the work now being done by the *Albatross* will, in the near future, prove of the greatest value to fish-culture and fishery economy.

Thus assured, I ask your attention for a few minutes, hoping not to tax too severely those who are familiar with the process of marine dredging, and trusting the article may be of some interest to our western friends, whose opportunities for deep sea fishing are naturally limited.

In the first place, a word about the *Albatross* and the purpose for which she was built. She is a twin screw iron steamer of 1,000 tons displacement, 235 feet in length, built in 1883 by the Pussey & Jones Co., of Wilmington, Del. She was constructed for the United States Fish Commission, and intended to make extensive trips along our coast and to other countries, for the purpose of making observations on the ocean fisheries. Her work, principally, consists in determining, by sounding operations, the temperatures of the water of the sea, the nature of the bottom, and the effect of the same on the migrations and breeding of the mackerel, cod, menhaden and other varieties of economic importance to our fisheries. When the vessel can be spared from the regular work of the Fish Commission, she is loaned to the Navy Department, who use her for the purpose of observing the ocean depths, surveying harbors, and especially in determining the existence of ledges and shoals hitherto unknown. Her crew numbers between fifty and sixty men. Her commander at present is Capt. Z. L. Tanner, U. S. N., and she is officered by lieutenants of the navy.

Mr. J. E. Benedict is the naturalist in charge, and there is generally associated with him on board a scientific staff of two or more to assist him in obtaining data and preparing specimens.

The ship is admirably planned and constructed. The captain's cabin occupies most of the after part of the deck, is spacious and well furnished with everything necessary for the commander's comfort. This cabin contains two staterooms, and is lighted during the day by port holes on the side and a skylight above on the poop deck. The officers' ward room is below this, having seven spacious staterooms, a bathroom, and other conveniences not generally found on steamships. The ship is lighted throughout with the incandescent electric light, which not only makes the wardroom particularly cheerful in the evening, but also illuminates the entire deck, so that at night the vessel, as seen from the shore, looks like a brilliantly lighted ball-room.

Another thing rendered possible by the presence of the electric light is surface collecting at night. Mr. G. W. Baird, chief engineer of the ship, is the inventor of a cable to which he attaches a screen-covered electric light. This, when the vessel is at anchor, can be lowered into the water just below the surface, and the numerous young fish, marine worms, squids and shrimp, attracted by the brightness of the light, are captured by means of a hand net and transferred to the laboratory table for examination. This laboratory is amidships. There are really two laboratories, an upper and lower; the first furnished with working tables, a sink, a library of books for reference, a microscope and convenient tanks of alcohol; the second, called the "lower laboratory," is below this, has benches for chemical work, and opportunities for general carpentry and work connected with the collections. Here guns are cleaned and mended, and here too are tiers of drawers in which specimens are stored. Beneath these drawers are large metal tanks filled with alcohol, for containing the larger fish and specimens whose size prevents them from being stored in the small glass jars. Below this second laboratory, in the hold of the vessel, is still a third storeroom, of much the same nature, and used for much the same purposes as the one above it.

The apparatus for deep sea sounding, which is placed on the port bow, consists of an easily running wheel supported in a frame. Over this wheel runs a steel piano wire from a cylinder

or drum, which holds about 4000 fathoms. When a sounding is to be made, a brass cup is attached to the end of the wire to catch and bring up some of the bottom, that its composition may be observed. Just above the cup is a thermometer which records the temperature of the deep water. To the above-mentioned cup a heavy shot is fastened to accelerate the downward motion. When a sounding is to be taken the ship is kept stationary, that the wire may be straight up and down, and. everything being ready, the weight sinks rapidly to the bottom, The concussion caused by striking the bottom detaches the heavy weight, at the same time the cup grasps a portion of the bottom's surface, and a donkey engine turns the cylinder, whereby the wire is quickly reeled in. Each sounding station is given a number, and a record is kept of the depth of the water, the nature of the bottom and the temperature at that depth.

A long article might be written on the various appliances and mechanisms of the ship, but it would be too great a digression from the subject originally proposed. Most worthy of mention, however, are the annunciators on the upper deck, placed against the wheel house. These are two contrivances, one for the starboard engine and a similar one for the port engine, which indicate to the officer of the deck the movement of both engines. This is also an invention of Engineer Baird, as is, too, the process by which the ship is furnished with a never failing supply of pure, fresh drinking water distilled from the salt water. Neither must I omit to mention the ship's boats which form so important a part of her equipment. A steam launch, a steam "gig," and numerous row-boats render effective service when in harbors. Now, as to deep sea dredging. Just forward of the wheel house, attached by one end to the foremast, is a boom capable of being raised like a derrick and swung over the side. Just below this boom is a donkey engine, and below that, in the hold of the vessel, is coiled a strong, wire cable, about one-half inch in diameter and about four miles long. This runs along the under side of the boom and over a wheel at its free extremity. To this end of the cable is attached the dredge, or trawl, as it is sometimes called. This consists of a strong, baggy net, fastened to what looks like a pair of huge iron sleigh

runners, kept at a distance of about eight feet from one another by means of an iron rod. It is between these "sleigh runners," in the intervening eight feet of space, that the net is placed. To these sleigh runners is also attached by ropes a stout canvas bag, the mouth of which is kept open by iron jaws. The position of this bag is just behind the small end of the net, and on the sea bottom it is dragged along after the large net, scraping up mud or sand and rocks, thus relieving the meshes of the net from a strain which would be too heavy for them.

Everything being ready for dredging, and soundings having first been taken to ascertain the depth, the net is lowered carefully into the sea, the progress of the vessel being stopped. If the sounding gave 1,200 fathoms then 1,700 fathoms of dredge cable has to be let out, or even more than that before bottom is reached. This has to be done slowly and necessarily takes a long time. Sometimes when the water is 3,000 fathoms deep, as is often the case, four hours are consumed in one lowering and hauling. This process is also called "trawling." When the bottom is reached, the dredge is dragged slowly along for half an hour and then hoisted on board by means of the donkey engine, at first slowly, then, as it gets clear of the bottom, very rapidly.

It is an exciting moment when the huge net and canvas bag emerges from the water and hangs dripping over the deck. The net is then opened at the bottom and its contents allowed to roll out into tubs, while mud and sand and rock in the canvas bag are emptied into a large sieve on the forward deck, then to be carefully washed and examined for small marine animals.

The contents of the net which have been emptied into tubs consist of many curious forms of life from the deep sea, which are carefully picked out and sorted, each class by itself, and then placed in glass jars containing alcohol. A minute report of each haul is kept in a book for that purpose.

Sometimes the "catch" is extremely interesting, beautiful specimens of *Actinidæ* (sea anemones), Corals; *Echinoids*, or Sea urchins, varieties not found in shallower waters. Also specimens of *Octopus* (the cuttle fish), rare sponges and deep sea forms of Holothurians, or Sea cucumbers. These latter so much dis-

like being torn from their ocean bed, that they often use a power given them by nature and split into fragments before reaching the surface. Rare forms of starfish sometimes delight the eye of the naturalist who is sorting the contents of the dredge; and deep sea fish, which, on being released from the tremendous pressure to which they were subjected in the deeper water, become distended by the gases contained within them and often burst, reaching the ship's deck in a rather dilapidated condition. Often, however, the dredge comes up nearly empty, or with but little life in it. To my question as to whether such work was not very disappointing at times, the captain replied: "Not at all; we consider ourselves fortunate if we get the dredge back safely," for it occasionally happens that the dredge and many fathoms of cable are lost by the catching of the apparatus on the bottom.

When the bottom is supposed to be so rocky that lowering a dredge would be unsafe, "tangling" is resorted to, which consists in dragging over the bottom large bunches of hemp rope attached to iron bars. These bunches of rope catch and hold in their strands small marine animals with which they come in contact. In the April 2d number of *Science*, Mr. Benedict has described the method of surface collecting, so I need do nothing more than refer to it here. It consists in dragging a large but fine-meshed net from the end of a swinging boom, along the surface and through the water just below the surface. It is often done on the port side while dredging is going on on the starboard side. This secures all the surface life found in the seaweed and just below the surface of the water. Varieties of *Tentennarius*, a little, brown-mottled fish frequenting the masses of seaweed, are caught thus in large numbers, as well as small crabs, which also live in the seaweed; a great many marine worms, various kinds of molluscs and other forms lower in the scale of life.

Washington, D. C.

SECOND DAY.

WEDNESDAY, APRIL 14th, 1886, 10:30 A. M.

The Convention was called to order by the Vice-President, Dr. Hudson.

The CHAIRMAN.—I am pleased to state we have received this morning some very interesting papers by mail and express, which will be read in the course of the day. Unless the Society shall order otherwise, I would suggest perhaps that we first listen to some letters which Mr. Mather has received, and which will be of interest to the Society. No objection being made, that will be the sense of the meeting.

The Secretary then read the following :

WASHINGTON, D. C., APRIL 10th, 1886.

FRED MATHER, ESQ.,
Secretary Fisheries Society,
Palmer House, Chicago, Illinois.

SIR:—I am requested by Col. McDonald to inform you that his baby died this morning, and it will be impossible for him to attend the meeting of the Fisheries Society, which he exceedingly regrets.

I send you by to-day's express, package of papers, minute book, etc.

Very respectfully yours,
J. J. O'CONNOR.

Dr. SWEENEY.—Mr. Chairman, if it be in order, I would move that the Secretary express our regrets at Col. McDonald's inability to come, and also our sympathy with him in his bereavement.

Carried unanimously.

NEW YORK, APRIL 11th, 1886.

FRED MATHER, ESQ.,

DEAR SIR:—I regret exceedingly that other engagements will prevent my attending the annual meeting of the Fisheries Association.

I trust that you may have a successful session and a large attendance.

Yours truly,
FRANCIS ENDICOTT.

WASHINGTON, D. C., APRIL 9th, 1886.

COLONEL M. MCDONALD:

I am sorry I cannot be with you in Chicago. I send you two papers: one by A. H. Clark, one by myself.

W. V. COX.

NEW YORK, APRIL 12th, 1886.

Mr. FRED MATHER,
Secretary American Fisheries Society,
Palmer House, Chicago, Illinois.

I regret being prevented attending meeting of the Society.

G. S. PAGE.

BAY CITY, MICHIGAN, APRIL 13th, 1886.

Mr. FRED MATHER,
Palmer House.

Unavoidably detained to-day. How long will you be there? Will come if possible.

D. H. FITZHUGH.

Mr. BARTLETT.—I would like to state that H. N. Russell, business manager of the Citrus Fair, now at Battery D Armory, has extended an invitation to the members of this organization to attend the Fair this morning, or at any time they may choose, in a body.

Dr. SWEENEY.—I move the invitation be excepted and that we proceed to the Fair immediately after the adjournment.

Which motion being duly seconded, was carried unanimously.

The CHAIRMAN.—I would inquire if the committee appointed yesterday is ready to report.

Mr. MAY.—Mr. President, the committee appointed to make nominations of officers for the ensuing year, beg leave to report the following:

For President, Dr. W. M. Hudson; Vice-President, W. L. May; Treasurer, E. G. Blackford; Recording Secretary, F. Mather; Corresponding Secretary, W. A. Butler. Executive Committee: Francis Endicott, chairman; F. N. Clark, S. P. Bartlett, Dr. R. O. Sweeney, Philo Dunning, A. N. Cheney, John Gay.

Mr. BISSELL.—I move the report be adopted, and that the

Secretary be requested to cast the ballot of the members present for that ticket.

Which motion being duly seconded, was carried unanimously.

The CHAIRMAN.—A matter which comes over from last year I suppose should be acted upon, and perhaps there will be no better time for it than the present. Those of you who were present last year, know that there was a proposed constitution read at the meeting of last year, and it has been published with the proceedings; it must be acted upon at this meeting. If the Society desires, the Secretary will read the proposed constitution, and then it may be acted upon either article by article or as a whole, as the Society deems best. The Secretary will read the constitution.

Secretary MATHER.—I would state by way of explanation that this Society has been known for years as "The American Fish-cultural Association," but that it was deemed best to change the title last year when the new constitution was formed.

It was moved by Mr. Bissell, and duly seconded, that each article be taken up separately and acted upon by the Convention.

No objection being heard this course was adopted by the Society. (See Constitution, page 3.)

Secretary MATHER.—Mr. President, I would like to say that we had a society called "The Central Fish-cultural Society," which met twice here in Chicago and died. Its first meeting was held in the Palmer House, on October 1st and 2nd, 1879, and the second was held in the Grand Pacific Hotel, on December 15th and 16th, 1880. We never met since.

Last evening there was a little meeting of the few survivors gathered in the Palmer House to view the remains, and this is the result, which I respectfully beg leave to submit :

THE CENTRAL FISH-CULTURAL SOCIETY.

A meeting of officers and members of the above Society was held in the Palmer House, Chicago, on the evening of April 13th, 1886. Present: Dr. R. O. Sweeney, S. P. Bartlett, F. N. Clark, Recording Secretary; and Fred Mather, Corresponding Secretary, all of the late Society. Mr. Bartlett was called to the chair. Mr. Mather stated that the object of the meeting was to determine what disposition should be made of the funds, if any, remaining in the hands of the Treasurer. Mr. Clark moved that they be paid into the treasury of the American Fisheries Society. Dr. Sweeney seconded the motion. Carried. The Secretary was instructed to inform Mr. Booth, Treasurer of the defunct association, of this action and the meeting adjourned.

Moved by Mr. Bissell that the thanks of the Society be tendered to the Central Fish-cultural Society for the donation of the remaining funds of that society, as soon as the treasurer acknowledges the draft and pays it.

Dr. SWEENEY.—As one of the mourners, I object to that kind of an acceptance. If we can't receive it with any more gratitude than that, I move we do not say anything until the money is paid over. Then they can pour out their affectionate regards for it.

Mr. FAIRBANK.—I think we can compromise this matter. I will amend Mr. Bissell's motion by moving that the members of this Society thank the other society for their kindly and benevolent *intentions.*

Mr. BOOTH, as custodian of remaining fund of the defunct society, stated that there was a small balance, the amount of which he was not at present prepared to state, but he would ascertain the amount of the same and turn it over to this Society.

The motion of Mr. Fairbank, receiving a second, was then put to a vote and carried unanimously.

The CHAIRMAN.—Unless there is an objection, Mr. Mather will proceed to read one of the papers before us.

Secretary MATHER.—Mr. Chairman and gentlemen: This is a paper on "Oyster Culture," from my own experiments at Cold Spring Harbor, Long Island, where I superintend one of the hatcheries of the State of New York, and also do a great deal of work for the United States Fish Commission, and this report I should preface by saying that while New York has four commissioners of fisheries, it has but one oyster commissioner, who is also one of the commissioners of fisheries—Mr. E. G. Blackford, and this paper is from my report to be made to him.

OYSTER CULTURE.

BY FRED MATHER.

Mr. E. G. BLACKFORD,
Commissioner of Fisheries of New York:

SIR:—I herewith submit to you the report on "Oyster Propagation" at Cold Spring Harbor, during the summer of 1885. I had watched the experiments of the late Prof. Henry J. Rice, the previous season, with great interest, and saw that while he hatched many oysters in the great tank, they came to nothing, because, as I believe, the temperature of the water was too high, the tank being in the sun without cover, and supplied with a very small stream of water through a ¼-inch hose. This tank was made of two-inch pine plank, twelve feet long six feet wide and three feet deep, coated with coal tar inside and out. I moved the tank to the north side of the fish-hatchery building where it would be shaded, and covered it with boards to keep it clean. The water for the experiments was supplied by a hot air engine belonging to the Fish Commission, and was pumped from our salt-water pond some 700 feet distant from the hatchery, and thrown up on the hill in a cemented reservoir, from whence it was brought into the building through two-inch pipes. Two to three hours pumping daily was all that was required for these operations.

We also made experiments in the large salt-water pond spoken of above. This pond is some 280 feet long, by 150 feet wide, and receives water at high tide through a flood gate which

holds it at all times. It will be noticed by the record given below, that the water in this pond, which has a depth of two to six feet, was warmer as a rule, than that in the wooden tank in the shade of the building, and it was in the pond that our greatest success was made.

We obtained oysters at the spawning season from the oystermen here, and these were opened, and all whose appearance denoted ripeness were selected and placed one side. The sign of ripeness was the peculiar fulness and milky appearance of the ovaries and spermaries which is readily seen by any person who is at all familiar with them. The oysters then, lying on one shell, were taken and the mantle and gills trimmed off with small sharp scissors; pressure was then applied with the scissors to the ovaries and the exuding drop was placed upon a glass slide under the microscope, where the eggs can readily be distinguished from the milt of the male, after a person has once had the difference pointed out to him.

The male oysters were separated from the female, so that we could see what proportion we had of each. Sometimes we would lack the male element and consequently could get no impregnation. At other times there was a fair amount of both sexes. The eggs were stripped from the female by pressure, and then the male was treated in the same manner, taking both the eggs and milt in an ordinary milk pan and adding water gradually. In a short time a drop of this water placed under the microscope would be seen swarming with the spat in the swimming stage of its existence, and then they were placed in the tank or in the pond. The bottom of the tank was covered with gravel, and scollop shells were suspended on strings across it. The current was very light and the spat seemed to sink and catch upon the gravel, for we caught none upon the hanging shells in this water. Toward the last of August, the tank was examined and the few oysters adhering to the gravel were removed and placed in the salt-water pond. The success in this wooden tank was not as complete as the experiment in the pond, and but few oysters were got from it.

During July and August, while the record was kept, the variations in temperature were very slight, while the density of

the water was remarkably uniform; the greatest specific gravity being 1,020 and the least 1,018, and the temperature of the water in the tank was at all times below that of the pond, in which the sun shone directly. We made no attempt to estimate the number of these minute eggs, which are only visible under the microscope, but took all we could get from the four bushels of oysters.

The bottom of the large pond was covered with scollop shells; stakes were driven about twenty feet apart all over its bottom and strings were stretched between these, while on the strings we hung perforated shells. We obtained a good "set" of oysters in this pond, the best on the shells at the bottom, and, while there was six feet of water in the center of the pond, we obtained no "set" whatever on the suspended shells beyond three feet from the bottom. At three feet we noticed an occasional oyster, within two feet of the bottom they were more plentiful, and increased as the bottom was approached. On September 19th, we drew off the pond and examined it for the last time before winter; there were thousands of young oysters of the size of a dime.

Prof. John A. Ryder, of the U. S. Fish Commission, has suggested an admirable way to collect spat, by means of a canal provided with ledges near the top to support receptacles for the cultch. These receptacles are formed by wooden strips and wire cloth, and hold about three bushels of shells each, the "basket" being three feet wide, three feet deep, and only six inches thick, so that the shells are thickly presented to the floating spat. The experiments of Prof. Ryder, have been very valuable, and so have those of Prof. Brooks, Lieut. Winslow, Prof. Rice and Col. McDonald in America, and those of Profs. Hock, Horst and Möbius, and M. Bouchon Brandeley in Europe. Prof. Ryder lays down the following principles:

1. "Oyster embryos under ordinary conditions in open water, diffuse and affix themselves throughout the three dimensions of such a body of sea water. This is a well-known and readily verifiable fact.

2. "The fry will adhere to smooth surfaces as well as to rough ones.

3. "The surface upon which spatting occurs must be kept as free as possible from sediment and organic growths, in order that the tiny young molluscs may not be smothered and killed during the most critical period of their lives.

4. "Artificial fertilization of the eggs of the oyster is feasible, and will become an important adjunct to successful spat culture.

5. "Water charged with embryo oysters may be passed through a steam pump without injury to such embryos.

6. "Oyster fry adheres to the under surface of shells or other collectors most abundantly, because the lower side is cleanest and most favorable to the survival of the animals.

7. "The spat of the oyster will grow and thrive with comparatively little light.

8. "The specific gravity of the water may range from 1.003 to 1.0235.

9. "The most favorable temperatures of the water for spatting seem to be from 68 degrees to about 78 or 80 degrees Fahr.

10. "Spatting will occur just as freely in ponds or tanks as in the open water.

"These are well ascertained elementary facts, and upon them we must base our new method, which is essentially a system of spat culture, or method of rearing seed oysters for the purpose of cultivation on the open beds or any suitable bottom. We must, however, first of all throw aside as too expensive any and all systems in which tiles or slates are used, especially if these must be fastened together in nests and coated with lime and cement, as practiced in Europe. Oysters are too cheap in America to be produced by any of the old fogy systems which are available there, as it will not pay to flake off the spat from the collectors under ordinary circumstances in cultivating the the American oyster for market, because of its low price."

The experiments at Cold Spring Harbor have attracted some attention from the oystermen about there, and some of them have expressed themselves pleased with the results, and incline to think that seed oysters could be raised in quantities by any person who had an inclosed pond such as ours, where the water came in at times of high tide, and that they would be reasonably certain to get a fair "set" on proper cultch.

The following is from the journal kept by my foreman, Mr. F. A. Walters:

July 1—Received first lot of oysters: opened one bushel, found 17 ripe females and 1 ripe male; took spawn from these. After 9 hours, as there was no sign of life, considered not good.

July 4—From half bushel, 9 females, 3 males, milt not active, no sign of life after 10 hours.

July 5—From half bushel, 11 females, 1 male. Three hours after taking spawn young were swimming; put in tank.

July 9—Put in tank 3 pans of spawn.

July 10—From 200 oysters 175 were ripe females, 18 not spawning, and 7 partly ripe males; had to lose all.

July 11—From 80 oysters 60 ripe females, 4 unripe males, and 16 not spawning.

July 14—Cleaned tank.

July 16—Ground-gate of salt pond had to be taken out owing to a leak, poor tides followed, pond did not fill for five days, could not pump and consequently no circulation in tank for that time.

July 20—Opened 70 oysters, found 20 ripe males, 30 females and 20 not spawning. Took two pans of spawn at 10:20 A. M., swimming at 2 P. M., put in salt pond.

July 22—Put spawn from 200 in salt pond.

July 26—Cleaned tank, could find no set.

July 28—Put in pond 4 pans of spawn in good condition.

July 31—Put in tank 4 pans of spawn, the best lot taken.

August 11—Cleaned tank, and put in spawn from 1 bushel oysters.

August 20—Discovered set in tank.

September 8—Cleaned tank, found a number of shells and about a peck of gravel with sets on, but all dead. There were no sets on the hanging shells; the reason for this, I think, is owing to lack of current, which should be quite strong; there is more danger of getting too little than too much. Lowered salt pond.

September 19—Found a good set; the hanging shells had sets three feet from the bottom, but the shells on the bottom did the best.

During July the temperature of the water in the tank ranged from 65 to 73 degrees, and during August from 70 to 74, while in the pond it ranged from 71 to 87 degrees. The density varying in each from 1.017 to 1.020, standing at the latter figure steadily from July 19 to the close of the season.

Cold Spring Harbor, N. Y.

Mr. BARTLETT.—Can you tell us what indicates the ripeness of the oyster?

Mr. MATHER.—The appearance of ripeness is a milkiness and swollen appearance of what you might call the body of the oyster, and when you press it you get a milky substance; in fact, the whole oyster is distended a great deal as a ripe fish is.

Mr. BARTLETT.—It is quite apparent then?

Mr. MATHER.—Very apparent to a person who is at all familiar with it, as I have explained in this paper.

Mr. CLARK.—I would like to ask Mr. Mather if any one has tried to make any computation of how much spawn there is in one female?

Mr. MATHER.—It has been done. I cannot give you the figures now, but I think if I were home and had access to my library I could very easily give that to you. I have an idea that perhaps an oyster of ordinary size may have nine or ten millions of eggs, and that it would vary as it does in the case of fish.

Dr. HUDSON.—The Chair would state in answer to that question that the estimates vary considerably, and many of them are made very much higher than what Mr. Mather has stated. It has been estimated in many cases as high as fifty millions.

Mr. CLARK.—Have you any idea of your own, Mr. Mather, what portion you impregnated?

Mr. MATHER.—I have not, because to get at this it will be necessary to go over the whole mass with the microscope, and you would have very few in the field at a time We made no effort to estimate the amount of any impregnation. We recog-

nise the fact that this thing is in its infancy. Several gentlemen have experimented before I did, whose names I mention in the paper read, and from whom I obtained considerable knowledge before I attempted it. I don't know what percentage we did get. We were contented to just work along, the main thing being to get ripe oysters and hatch something, doing the best we can. There is no trouble in hatching them. Every year along our bays and harbors there is a greater or less amount of spawn.

Mr. FAIRBANK.—The set has been found to be best, I understand, on the bottom ?

Mr. MATHER.—Yes, sir; but where there are swift tideways there comes a time in the life of the little oyster when it wants to settle down to steady habits and quit this roving life, and whatever it takes hold of must be clean, and if it falls down in the mud it is gone. You can easily see, gentlemen, that in a state of nature, many millions of spawn must be sent out and but few are impregnated. When the female oyster gets ready, she opens her shells and lets her eggs go, and they must run their chance of a current from somewhere bringing them to the milt of some male oyster who has also just reached the supreme moment, and the chances of their coming in contact at the proper instant of course are very small. The great mass must remain unimpregnated, and then, of those which are impregnated, many of them fall into the mud and into other unsuitable places, not to mention dangers after their shells grow.

A MEMBER.—Would the impregnation by artificial means be an economic way ?

Mr. MATHER.—I think so, and I think Prof. Ryder thinks so too, and the means which he gives to catch the spat I think to be a better way of procedure than the process I have adopted.

Mr. BOOTH.—I think perhaps it may be interesting to some of you gentlemen to give you one of my little experiences. The results I have just heard are very good, very nice indeed. It shows that oysters can be propagated, but it can be done so much more cheaply and in a more practical manner. Some four years ago, I planted 12,000 bushels of shells that we had

thrown away in the week, in the water in Delaware bay, where there were no shells or oysters in the neighborhood. Last year we took up from those shells, without planting any oysters on them a little over 40,000 bushels of as fine oysters as you ever saw in your life, and I think there are quite as many left on that ground. I say this to give you a little idea of how rapidly oysters will grow. If they would only plant, as Mr. Mather says, the proper shell or material at the proper time, that is all that is necessary. The time oysters spawn is usually in June or July, varying according to the warmness of the atmosphere and the condition of the water. Those are the months that they spawn, and at the time that the oysters are ripe throw over your old oyster shells and try and have no fungus or vegetable matter on them and the spat adheres to those oyster shells and you have no difficulty in getting more oysters than you can handle. Just take oyster shells and scatter them and you will find oysters enough to re-supply the whole territory. I have done that on the Delaware and also on the Baltimore, but in Chesapeake bay we have no right to any grounds there, have no title and consequently no water. In the Connecticut waters this has been done for the last eight or ten years, so where there were no oysters a few years ago there are millions of bushels. Of the enemy to the oyster there is the starfish ; they come sometimes in myriads and they kill all the oysters, unless they are taken up and removed to some other place. There is not the slightest trouble in the world to replenish our oyster product on this coast or any other section of the country where you have warm weather in June or July.

Mr. MATHER.—From Mr. Booth's remarks it may be inferred that our mode of artificial hatching is not adapted to practical work. We think that it is. The method which he speaks of is a very old one and often is all that is sufficient, but there are years when the oystermen will tell you "there is no set," meaning that the young failed to hatch or to catch on to something after hatching. Often a heavy rain kills the swimming oysters, or there may be currents which take the eggs to sea. It will readily be seen that the conditions must all be favorable in

order to secure a good set, and nature provides for the loss of immense numbers of eggs and embryo oysters, and it is this great waste which we are trying to save. If we do no more than to mix the eggs and milt together it is a great improvement on nature's methods which only brings an occasional egg within reach of the fecundating fluid.

Dr. Hudson.—I could talk of course on this subject for hours, for this is a matter we have had a great deal to do with in Connecticut for the last six years. I would simply add to what Mr. Booth has said that in Connecticut and on Long Island Sound, the time for spawning oysters varies from about the middle of June to the first of September. It is governed entirely by the depth of the water. Where the water is shallow it becomes warm more rapidly than where it is deep water. Oysters there grow where it is ten feet deep out to where it is ten fathoms or sixty feet. Mr. Booth has described sufficiently for practical purposes the method of cultivation, which is the one universally carried on there, and were it not for the starfish, as he has said, I think the product would be almost unlimited. The only other enemy that we have on Long Island Sound is the drill, which is nothing like as dangerous in its effect as the starfish. There is another enemy to the oyster in portions of New York State—the drumfish, a very powerful fish with powerful jaws, which crushes the oyster and destroys a good many. It is called the drumfish owing to the peculiar sound which it emits, and which can be heard by those who are immediately over it.

Mr. Bissell.—I would like to ask if your Commission have ever attempted to spawn the oyster, or have you simply attempted to catch them in the water?

Dr. Hudson.—We have never done that as a general thing. Some of these experiments have been made, and the most interesting one in our water was by Lieut. Winslow, who has been engaged in this business. He came to Connecticut some four or five years ago; he had a can invented, and he could drop this can to the bottom of the Sound, and then when it reached the bottom by a peculiar contrivance he could pull out the bot-

tom, so whatever was inside was let loose. Just previous to that he had taken oysters in the same manner which Mr. Mather has described, and had hatched out a very large number. You gentlemen may be all aware, probably, that the great difficulty up to a very recent time has been to induce these young oysters to live beyond three days. There has been no difficulty about hatching out oysters and in keeping them alive through what is called the free swimming stage, which is about three days. At the end of that time it is their nature to attach themselves to something and they have invariably, up to a very recent period, died when they reached that stage. Some recent experiments have been made by which they have succeeded in carrying them beyond that. Prof. Rice, whom some of us have met, told me he had succeeded in carrying some of them three or four weeks.

Mr. MATHER.—Yes, in a small aquarium, but they finally died.

Dr. HUDSON.—The experiment that was tried in Connecticut was to take these young oysters during this free swimming stage, put them down on good bottom on Long Island Sound and there release them. The product of that particular locality was remarkably good afterward, but the general set of the sound was so great that it was very difficult to appreciate just how much the set was increased by this peculiar process. As Mr. Booth has said, the system that was adopted in Connecticut of distributing clean shells has been attended with great success. Some large dealers distributed as many as three thousand bushels of shells, during the season and the young spat cling to the "cultch," as it is called, in immense quantities, such quantities that in very many instances they have to be culled out and removed to other localities for fear that they will smother each other, and as I said before, were it not for the enemies, the amount of oysters which might be produced would actually be almost unlimited.

Mr. FAIRBANK.—When are they destroyed by starfish?

Dr. HUDSON.—Generally when they are very young. The starfish is a very peculiar animal. They have a faculty of extruding the stomach and covering the entire oyster or other

mollusk. They surround a little oyster, perhaps the size of a half dollar, more or less. The starfish puts its fingers round the oyster and it is supposed by some, smothers it, so that it has to open its shell; by others it is supposed that the starfish emits a peculiar acid, which obliges the oyster to open its shell and then the starfish protrudes one of its fingers into the shell and devours the stomach of the oyster.

FISH-CULTURE—A PRACTICAL ART.

BY JOHN H. BISSELL.

I do not forget, gentlemen of the American Fisheries Society, that I am but a student in the craft which we profess, and for the encouragement of which this Society exists; nor that many of you have grown gray in this honorable, nay, may I not also say, patriotic, service; and so I should be sitting at the feet of some piscicultural Gamaliel, instead of standing before you as an essayist, but for the summons of your committee which left me no room for excuses or refusal.

A younger generation is coming upon the field to take its part in carrying forward fish-culture, to apply the precious stores of knowledge, which have been laid up by the practical observation and scientific research of the past twenty-five years, to the practical solution of some very important economic questions that are beginning to clamor loudly for solution.

The question most urgent just now is not, can fishes be artificially hatched and reared, and acclimated in alien waters, but can the fisheries of this country now be saved? That the men of whom this question is being asked are the members of this Society, once called "Fish-cultural," may not improperly be regarded as evidence of the ability with which the elder generation, the pioneers of fish-culture, have done there work, as well as of the value of their work and the appreciation in which it is justly held by the people of this country.

At former meetings of the Society you have been favored by the eloquent speeches of statesmen who judged rightly that fish culture was worthy the statemen's consideration. Unless the statesmen of this generation have lost the art of wise and wholesome statecraft, we shall hear from them still further on this subject, if not in our deliberations, yet more potently in the State capitols and in the halls of Congress. You have been honored by papers and addresses from men of your own number who have won distinction by knightly deeds—no less knightly and honorable because won in the unromantic armor of waterproof coats and rubber boots—in conflict for the secrets of nature, wresting from nature's willing hands the knowledge that practical men have been gathering and storing up against the day when the millions that are peopling and are to people this continent, shall cry out for more and better and cheaper food. You all know the men to whom I refer, so there is no need of mention of their names. I know them, not by personal acquaintance and familiar discourse, but none the less really, through their writings and experiments, which have made it possible for men of the class to which I belong to accomplish something for the States which have honored us with the oversight of their fishing interests. Without the knowledge which has been gained and freely disseminated by these intelligent and devoted men, the fishery establishments of many of the States would have no existence, or their officers no reasonable and sufficient answer to make to their State governments when asked as they so frequently are, "Can fish-culture do anything worth the expense for the food supply of the people of this State?" Have we then any such answer to make? That we have, —that the answer is reasonable and sufficient I shall try briefly to show. While we have not learned all there is to know about the culture of fishes and artificial propagation of them, enough is known both scientifically and experimentally to place the practical art of fish-culture beyond the domain of mere curious research, and make it a useful, and to the same extent, a necessary department of the public business. To this practical aspect of fish-culture I invite your attention. In using the expression "fish-culture," I mean to be understood as including

artificial propagation of fish and the protection of them until they are marketable.

Consideration of fish-culture as a department of the public business is growing every year to greater prominence, particularly in the States bordering upon the sea and the great lakes. Of course I only profess to speak with accuracy about the condition or needs, of the fisheries of my own State—Michigan; but, the state of affairs there is in some measure analogous to the circumstances of other States, and the subject from my point of view may prove of more than merely local interest.

Are our fisheries worth saving?

Michigan has a coast line of more than 2,000 miles in length upon the great lakes and their connecting rivers, by actual measurement upon the Government charts. Its fisheries produce annually over 13,000 tons of food, the value of which is something over $800,000 at first cost. The capital invested in the prosecution of this industry is about $1,200,000; it gives employment to 1,800 men, which means that over 7,000 people are dependent upon the prosecution of the fisheries for their living. The pound nets used in this industry placed end on end will stretch 200 miles, the gill-nets placed end on end measure 1,588,852 fathoms—over 1,800 miles.

From this brief statement it appears that Michigan has industrial fisheries that are worth caring for. A few additional facts will show that they need care. Forty years ago at one of the seine fisheries on Detroit river, the number of whitefish constituting a fair catch was from 90,000 to 115,000 fish, averaging in size about four pounds. That fishery has been abandoned for more than fifteen years, and the last vestige of docks, houses and pounds have rotted away. Another fishery having as fine a plant as any on the lakes, about nine miles below Detroit, as late as the fall of 1883, had over 12,000 whitefish, which was thought the poorest catch ever known. In 1884, at the same fishery the total of whitefish was 3,400, and for the season of 1885, less than 2,000 whitefish were taken there by actual count. This we know, for we bought and handled the entire catch to take the eggs for the State hatcheries. At many points on Lake Michigan hundreds of thousands of whitefish under one pound

in weight, one, two or three years old, which have been planted, have been caught, shipped to market when worthless, or thrown upon the shore to rot as not worth handling, or salted and sold as herring. Such complaints have come to us by the fishermen themselves and by nearly every dealer who handles Michigan fish.

But there is not space here and now to multiply examples to prove, and I therefore content myself with stating the facts very generally. In Michigan waters every year, the area of fishing operations is greatly extended; miles of ground once productive are abandoned; the average size of whitefish is gradually growing less; the price is gradually getting higher in the market; and while some large firms are getting fairly profitable returns, the fishermen as a class are getting poorer; where formerly the nets were served by sailboats and rowboats, steamboats are fast coming into common use; the demand for fish is increasing steadily as the population increases; the total supply is comparatively stationary or falling below the increasing demand; and all this means that the fisheries of our lakes are fast becoming exhausted and ruined. These facts suggest some pertinent inquiries, just such as are being asked of the State Fish Commissioners by the representatives of the people every year. Has artificial propagation then been a failure? No, for it has not had a fair chance in several ways.

First—It has not been conducted upon a scale adequate to accomplish the results.

Where we are hatching about fifty millions of whitefish we need from six to eight times that number every year to restore the wasted and deserted grounds, as also to replenish and keep up the stock in others yet productive. Numerous early experiments were made of planting whitefish fry in interior lakes of various sizes, where we now know they will not thrive because the conditions of food and temperature are not favorable. This could not be known without trial. But it does not follow that the experiments should not have been tried. It was no waste of time or money. The lessons learned from such failures are perhaps more valuable than constant successes. There are large and deep lakes in the interior of Michigan and other States

where the whitefish are indigenous. In such lakes they can and should be grown to the utmost capacity of the food supply. Such lakes in Michigan we are planting now as preserves from which to draw a future stock of breeding fish, to furnish eggs for keeping up the supply for the industrial fisheries of the Great Lakes.

There are many localities on the Great Lakes where the planting of whitefish has resulted in the appearance of vast schools of small fish coming in upon the inshore feeding grounds, during the summer months, at points where that phenomenon had never before occurred within the memory of the oldest fishermen. That they were the planted fish is beyond question, as it is not doubted by the practical fishermen and others who have examined them, that these young fish are identical with the Lake Erie fish, that being the source whence all our ova and almost all of that used by the U. S. Commission are taken.

Second—Artificial propagation has not had a chance in point of time.

It is only within the first few years of the second decade of its existence—say from 1882 or 1883 that we ever hatched and planted over 15,000,000 of whitefish in any one year. The same period will cover also the most extensive operations of the U. S. Commission in this direction. The force of this point will be appreciated when it is understood that from our present knowledge we have no reason to expect important results from these plants before the expiration of four, I think probably five, possibly six years, from the time of planting. Operations during the first decade were, as I have said, only experiments, and they were successful beyond anything that we could in reason expect. In summoning this practical art to the judgment hall, it must not be overlooked that the ruin caused by wasteful and unconscionable fishing methods, which it is called upon to repair, has been going on for thirty or forty years. And it is always more difficult to cure than to prevent disease, whether physical, political or economic.

Again, fish-culture has not had a fair chance with us, and I am informed the same is true of almost all the States, because

we have lacked proper municipal regulation of the fishing industry.

It is not enough that the State Commissioners should be able, at very moderate cost, to hatch and release in the lakes enough young fish to take the place of the adults captured and marketed. The young fish so hatched and released in the waters must be protected until they come to maturity and are marketable; otherwise the wasteful fishing, which has once depleted the waters stocked by nature, will do the same thing, only more surely and speedily for the waters replenished artificially.

So the two things must go together. Artificial propagation cannot do it alone; municipal regulation cannot do it alone, within a period that will avail anything for one generation, possibly not even then. The two things are mutually dependent conditions, they must concur to assure valuable or lasting success. In the combinations of these two conditions we have the complete definition of the *practical art of fish-culture.*

There is not time here to go minutely into the facts or the arguments which logically flow from them to support the necessity for proper inspection or regulation.

I can only point out generally that municipal regulation, to be of value in saving or extending the operations of the industrial fisheries of the great lakes, must cover these points, namely:

(*a*) The sizes of the meshes of the nets to prevent the destruction of immature fish.

(*b*) Market restrictions as to the size at which various kinds of fish may be handled or sold.

(*c*) Prohibition of inshore fishing during the season or at the points where the young fish are running in to feed.

(*d*) Discretionary authority to allow the use of nets below standard size at certain times, in certain localities, for certain kinds of fish.

(*e*) The demarcation of spawning grounds and their absolute rest from fishing at the spawning season; or, if that is impracticable, a "close season" at spawning time.

(*f*) Inspectors and wardens of the fisheries with ample means and powers to enforce all regulations, whether of apparatus, fishing operations, packing or marketing.

(*g*) A reasonable and equitable system of license, which will furnish the means to pay the cost of inspection and regulation, and also of replenishing and keeping up the stock by artificial propagation.

There is one more requisite which cannot be provided by statute law, the spread of reliable information of our purposes and operations among the fishermen and fishing communities, which will create a strong public opinion in support of the laws and their stict and just enforcement.

It has been urged that this whole business of fishery regulation should be undertaken by the Federal Government, so far at least as the fisheries of the Great Lakes are concerned. Is there any reason why the Federal Government should undertake the establishment and enforcement of fishery regulations in the States bordering the Great Lakes, that does not apply with equal force to the obligation of assuming the burden of the other department, that of restocking and maintaining the supplies of fish in the same waters?

The reasons for this course or the desirability of it are not to my mind clear. The subject of fishery regulation is one, even if it were a new and open question, which seems from the very necessities of the case to be so local, domestic and municipal in its character as to fall naturally within the police power of the several States, and not within any defined powers of the Federal jurisdiction, legislative or judicial. But it is no longer an open question. It has been passed upon by the courts of last resort in almost all the States, as well as by the Supreme Court of the United States. And this view seems to have been adopted by all the States that have established fishery regulations, however meagre and insufficient, as well as to have been acquiesced in by the United States Congress by a century of silence.

But what can the practical art of fish-culture as above defined (although but briefly and imperfectly outlined) do for the fisheries of the Great Lakes? What promise does it give which will warrant the expenditure of public funds in its prosecution? I hardly need to make answer before this assembly of its disciples, or rather its discoverers; but that same echo, however faint, of these questions and the answer, may possibly reach the

dull ears of our people, and their representatives who make the laws and provide the means, and who are charged by the law of the land with the responsibility of preserving the public weal, let it be said without hesitation. All barren waters may be made productive again! The ruin of the great industrial fisheries of these great public domains may be arrested! The fisheries that produced thirteen thousand tons of food fn 1885, may be brought up to the production of thirty, and then fifty thousand tons of wholesome nutritious food within the reach of all men! The money value in yearly product may be increased from one to five millions of dollars, and contribute no mean share to the prosperity of a great State, and the well-being of its citizens.

Detroit, Mich.

Mr. Booth.—I would like to state for the benefit of some of the gentlemen here, to show the enormous results to be derived from fish-culture, that at the cannery I am interested in on the Columbia River, in the state of Oregon, they pack 600,000 cases of salmon per annum. It is worth four to five dollars a case on the ground. Now you can readily see that is $3.000,000. It takes three fish to the case. That is less than 2,000,000 of fish. Now the salmon there produce, I understand, from 15,000 to 20,000 fry, so you can readily see it doesn't take many salmon to re-supply by artificial propagation the salmon that are taken from that river to produce $3,000,000 per annum. In other words, we catch 3,000,000 of fish which produce $3.000,000, and they can be replaced by artificial propagation for at least $10,000 in money. Now if there is anything in this world you can speak of that will produce so much for so little investment, I should like to know it.

Mr. Bissell.—Mr. Booth has spoken about the comparative cost of policing and artificial propagation. It is a very comprehensive subject, and I have stated in outline in my paper just what my conclusions are, drawn from a great many facts and a great deal of thought and consideration of the subject. It is true that artificial propagation, if carried on on a proper scale, can be done very cheaply. I made some figures for presentation to the committee by our register two years ago, and if I re-

member rightly it was something like this: That if we produced about three hundred millions of whitefish in the way that we were then and are now doing it, that the cost per thousand fish planted in the lakes wherever they were to be be planted, would be about one-third of a cent per thousand. I think it was that —one-third of a cent, or less, per thousand. After you get over a hundred millions you begin to scale down the average very rapidly. Even if it were a cent a thousand, I think that the cost of proper policing, inspection and regulation of the fisheries will not cost what Mr. Booth seems to indicate. We asked the last Legislature to give us $15,000 for two years' work. That was on a careful estimate of what we could get an inspector and probably four or five wardens for. It will not be necessary to police the entire 2,000 miles of coast to prevent the use of nets of improper size if we have the power of inspection. If we could go to Mr. Booth's packing house, if our inspector could go there with ample authority and power to seize and confiscate all fish that were under one pound in weight, then Mr. Booth would not buy those fish any more. It would not be necessary for us to go a thousand miles to prevent all intrenchment on the coast if we could go to the market and inspect there. That is one way. Another way is when the nets are being made up, we could inspect the nets and seize those which were under the size. Another thing I indicated in my paper was about forming a healthy state of public opinion. We have taken some pains in reference to that, and in the latter part of February or early in March, we succeeded in securing a meeting of representative fishermen of Detroit. I think there was something over fifty fishermen present. That meeting went so far as to perfect an organization, which I hope will be permanent among fishermen for the discussion of useful knowledge and practical good sense with reference to the purposes and and the objects, and this work among the fishermen will go as far as anything else towards the enforcement of the law. I doubt if among the three or four hundred fishermen in Michigan with whom we have been in communication the last year, there are half a dozen that would not be prosecuted if we had reasonable laws to regulate the fisheries; so that the cost of police power exercised

with reference to the fisheries I think is very slight, and the importance of preventing the capture of small fish is not by any means an insignificant part of rearing marketable fish in great numbers. A single man with a pound net, such as I know of near the straits of Mackinaw, where he couldn't find any net with a mesh that was small enough, he used sacking for the back of his pound net so nothing could get through. Such a man as that might destroy a quarter or a tenth of the product of one of our large hatcheries.

There is another thing in that connection. I say these fishers must be licensed, not only as a part of the exercise of police power, but to protect the citizens of the State. Now, it would not be fair if the State of Illinois were spending fifteen to twenty thousand dollars to stock the shores of Illinois and Michigan with whitefish, for my friend Dewey to come over here and catch all those fish and ship them to Toledo and Cleveland; neither is it right that the people of Illinois and of the city of Chicago, should be fed with fish which we have planted in the waters of Michigan. Now, for that reason I want the fisheries of Michigan to be licensed. I want a regulation which will prevent Mr. Booth from coming into our territory and catching our fish unless he pays a license. I know Mr. Booth will do it. He would be very glad for the right to use good fishing ground, just as any of us gentlemen would be very glad to pay for the right to fish in a pond where we knew there were three pound trout in great numbers. Now, when we get to that point, the fees that will result from a very reasonable and very low license, our fishing will not only pay all the cost of regulation and inspection, but it will pay all the cost of hatching and planting as many as Mr. Booth thinks we ought to plant in Lake Michigan. It will pay for hatching and planting six or eight times the fifty millions that we are now hatching.

One other thing has been alluded to and that is the question of what the United States Government should do. I said in my paper very briefly that the question of the regulation of the fisheries was officially settled. It has been settled for more than thirty years, although it has not been generally understood. The United States Supreme Court has passed definitely and

finally on that question. The regulation of the fisheries of each State out to the State border is a matter of municipal regulation, a matter of State legislation. That is so even in tide water. In the State of Maryland they passed a law preventing the dredging for oysters, and the State officers have seized a boat that was doing that, a vessel which was chartered and which was registered in the United States Customs office at Baltimore. She was replevined from the State constable who seized and condemned her, and under which proceeding she had been sold. That case went from the Supreme Court of Maryland to the Supreme Court of the United States. Benjamin Curtis being the justice who gave the opinion, said that the condemnation was right, that it was within the police power of the State to regulate fisheries of that State to the State border, and it was not a matter for the United States Government to interfere with, yet it was in tide water, and notwithstanding the vessel was one which was registered in the United States Customs Office, and although the United States Government had the right to regulate the navigation of those waters, the control of the fisheries was within the police power of the State. At a meeting of the Commissioners held in October, 1883, at Detroit, this subject was very fully examined and presented to the meeting by the Attorney General of the State of Michigan very clearly and forcibly. That I regard as entirely final.

There is one other thing I want to speak of that Mr. Fairbank referred to, and that is the work of the United States Fish Commission. Now, if any gentleman will take the pains to examine the law under which the United States Fish Commission is constituted, he will see that the sole purpose of the creation of that commission was to procure scientific researches with reference to the fishes, the fisheries and the food supply, and see what the causes of the decrease were. It was also deemed proper under the definition of that law to undertake experiments in artificial propagation, but it was not the purpose of the United States Fish Commission to stock the waters of the United States. The procuring of information by scientific research, which we could get in no other way, has been admirably done by the United States Fish Commission. The planting of whitefish in the Great

Lakes and the propagation of shad have only been incidental to the work of the United States Fish Commission. It was directed that under that law and the provisions to carry out that law that they should make experiments in artificial propagation, and because, in the course of their experiments, they were able at very slight increased cost, to get more eggs than they wanted for that purpose, it was thought to be perfectly right to return the fully developed eggs, young fry, to the waters where they were taken from, and also to plant some of the young whitefish in interior lakes where they did not exist, to see if they could not be propagated there ; but it is not the purpose of the United States, and it is not the business of the United States Government, as I contend, to plant our own waters. That is our own business. The waters are ours ; they are under our own control ; they are just as much a part of the State as is the land of the State, and it is the business of the State, therefore, to see that its public waters, which are its only domain left, should be properly cultivated and properly used.

Mr. Booth.—I must beg to differ with my friend with reference to the amount of the cost of policing and propagation. From his own figures, and the most exaggerated estimate of the cost of propagation of whitefish or trout, it would be about one cent a thousand if we have gathered twenty-four millions of pounds, in other words, eight millions of fish. Now, at one cent a thousand, how much is that ? It is about $800. It seems to me that is very much the cheapest way of reproducing the fish in these lakes. You could scarcely hire one man for less than $800 a year. I thoroughly indorse his ideas for exacting a license fee from any and everybody, from every man engaged in catching fish in the waters of the States of Michigan or Illinois or anywhere else. I believe that is a great source of revenue. I don't want to ask the United States Government to assist one dollar in this matter. I think the people that are making their money out of catching these fish are perfectly willing to pay a license for the privilege of doing so. I have a great many nets and a great many boats, and I am perfectly willing to pay a license if that amount is spent for the reproduction of the fish. These small meshes—you say they have put in canvas to catch

them—I would allow them to use canvas if they please to catch them. How long would it be if you put in fish at one cent a thousand in the waters—these small fish are comparatively worthless—before they would increase the size of the mesh and they would catch nothing but the big fish? It would be only four or five years before you would be willing to reduce the size of the net. There are a few unscrupulous men, I am sorry to say, belonging to the business I am connected with that would use those small meshes, but they are few. If there is any way you can reach them, you have my indorsement to do so.

Mr. Bissell.—They are all in Wisconsin.

Mr. Booth.—Well, Wisconsin has not got so much territory to fish in as the State of Michigan. We tried that on the Columbia River. There was a law passed in the State of Oregan licensing every boat at so much a piece, and every fisherman. I think it was $10 for a boat, and $5 for a fisherman, to the fishermen who fished with a boat. The law was passed and they collected the license, and they agreed to spend the amount of money they collected to the propagation of salmon in that river, and one of these foreign knights of labor or communists—or other classical name, I don't know what they were—he discovered in his great learning that it was unconstitutional. We were getting along nicely and everybody was paying his little license, and he thought it was unconstitutional. Well, he refused to pay and we sued him and got a judgment against him and went up to the last court, and it was declared unconstitutional. Now, we may strike such a thing as that. I don't think the people of the States of Illinois or Wisconsin or Michigan would resort to such a course. I think they would be perfectly willing to pay a license; but I must say I think the cheapest way we can reproduce our fish is by artificial propagation, and not with this vast amount—I think you say it will take eight or ten thousand a year—for policing, and it will be only a few years before you accomplish all which you now seek to attain.

Mr. Fairbank.—I want to say one word on the subject of the general Government taking hold of the thing. I understand Mr. Bissell to state the purport of the law as it exists, and also

the expenditures of the money that are made. Now, a considerable amount of money has been expended in artificial propagation—more in shad than anything else—and I can see no reason why it is not a subject that the general Government should take up and spend money upon. There is an injustice in the State of Ohio, for instance, spending money in hatching shad and depositing them in the Ohio River, when they go down the river and are caught all the way down the river. Louisville, for instance, would spread her nets and take the fish propagated by Ohio, and the fish that Michigan propagates Illinois will catch, for whitefish migrate, and so they do in all the waters; and it is an expenditure from which all the people would reap an equal benefit, and an expenditure purely within the scope of the general Government to take hold of. I want to see the present law amended. I want to see some action on the part of parties interested in this matter with our representatives, to have some legislation on the subject, and some new restrictions put upon the appropriations. The scope of the United States Fish Commission, their labors and their work, have been very much enlarged since the passage of the first bill, since the appointment of the first commission. There is only one commissioner. There should be more than one commissioner. There should be three or five commissioners, representing the different interests. A larger amount of money should be appropriated, and the work and scope of the commission should be very much enlarged. That is the idea I want to get before the meeting.

Mr. CLARK.—In regard to this question—speaking as Mr. Bissell did in his paper in regard to showing results to the people and to his legislature and other legislatures, I wish to say to you who were present last spring when this paper—this poorly gotten up paper—was presented by myself, you will remember I gave you some facts in regard to what we could show that artificial propagation and planting of whitefish had done in the great lakes, and why I claimed it must be due to that, because it had shown quicker in that than in any other way. The figures I gave you go to show it. They show there that there was some 65,000,000 or 70,000,000 of whitefish that had been planted up to a certain day in 1882 in Lake Erie. From all the facts we

could learn in our gathering statistics a year ago last fall, it showed they were on the increase there. These fishermen say so here in the lower end of the lake, but not in the upper end of the lake. That goes to show again that whitefish do migrate; that the whitefish planted in the Detroit River by the State of Michigan and in the upper end of the lake by the United States Fish Commission show the increase more in the lower end of the lake. It goes to show your fish migrate. Now the fish that are hatched by the Michigan Commission are caught down in Erie, Pa. Is that right to do that?

Mr. BISSELL.—I would like to ask if whitefish are migratory to the extent it is claimed, why they don't migrate back to the grounds that have been once fished in Lake Michigan?

Whereupon, upon motion duly seconded, the convention adjourned until 10:30 o'clock A. M. to-morrow. Wednesday, April 14th, at the same place.

INTENTIONAL AND UNINTENTIONAL DISTRIBUTION OF SPECIES.

BY DR. R. E. C. STEARNS.

The geographical distribution of species is one of the most inviting fields which nature offers to the student. Once entered upon, every path is found to lead to new and attractive vistas, and to point the way to curious and interesting phenomena. At every step we receive delightful impressions, and from every side, hints and suggestions as to nature's methods.

Through the estabiishment of the United States Fish Commission and of Fish Commissions in many of the States, as well as by the organization of societies and various private enterprises, the propagation of food fishes has become an important protective resource, and the economic aspect of ichthyology has been made familiar to a great number of persons. Incidentally, too, but to a smaller extent, the scientific side has attracted increased attention from a class of persons who would not have

become interested in the biological aspect if the latter had been presented to them first. With the selection of species for propagation and distribution, there naturally followed the investigation as to the habits, habitat, etc., of each selected species ; and one inquiry led to another, for in order to insure success from the business standpoint, it is necessary to pursue as closely as possible the various steps, and follow the various methods and order that nature follows. So a knowledge of the character or peculiarities of the environment or native haunts of the selected species has to be obtained.

Preceding the distribution and planting of the young fish, occur the inquiry and consideration of the factors or physical character of the region in which it is proposed to make a plant and so on. In this way much special and abstract knowledge is accumulated and brought to public attention, and more general notice ; the laws of life are better understood and the relation of species to species, and of all life to its environment, are made more clearly perceptible and more widely known. It will be seen by the foregoing that fish propagating operations and enterprises, both from the scientific and natural history side, as well as from the economic point of view, are incidentally useful as promoters of public education.

I am sure it will not be an uninteresting digression if we turn for a few moments from the consideration of the distribution of species by natural methods, that is to say by the hand of nature, as well as that intentional and artificial distribution by the hand of man, which is such an important and interesting part of modern fish-producing operations, to take a glance or side view through the collateral vista of unintentional, accidental, or more properly incidental distribution, and see what or where it leads to.

The transplantation of animal and vegetable species from their native haunts to some other part of the earth, more or less distant from their indigenous habitat, as an incident of traffic or commercial intercourse and enterprise, has many peculiar and striking illustrations. We have a notable example in the geographical distribution of the common rat. With the extension of commercial intercourse and international trade, the brown rat

or, as it is often called, the Norway rat, as a species, became more and more cosmopolitan. At the beginning of the last century this rat, a native of India, made its appearance in Europe, having stolen a passage on the ships engaged in the India trade.

It first appeared in England in 1730, and twenty years later it had reached France. In Europe it drove out the black rat which appeared in that continent during the middle ages ; the black rat coming from no one knew where, having previously driven out the native mouse which was the only representative of the family known to the ancients. At the present time the brown rat is everywhere, pretty much ; on the main lands of the globe and the islands of all seas, wherever commerce sends its ships. So too with the cockroaches (*Blatta orientalis*), a very cosmopolitan and very disagreeable form of insect life. These two familiar species are exceedingly active animals, and make their way on board of vessels or hide in packages or merchandise, and are thus carried on ships or cars, their inconspicuous size enabling them to steal a passage.

Again we have other illustrations of unintentional distribution by man, where the trees, plants or seeds of one region are sent to another. Upon the trees and plants thus transported often occur forms like the scale bark lice, *Aspidiotus* and *Lecanium* ; also the eggs of various insects. Many seeds contain the grub, maggot or larvæ of insect forms. If the roots of the trees or plants are protected by a ball of the earth in which they grew, and the earth if protected, by a cover of bagging, from crumbling away and separating from the roots, a precaution which is usually practiced by careful nurserymen, both earth and bagging afford a hiding place for small animals, such as insects (and larvæ of insects), worms, slugs and other small forms. If traffic, through the facilities of its machinery, assists in distributing plans that are useful to man, by the same system it contributes to his discomfort and pecuniary loss. It is highly probable that the scale bark lice, *Aspidiotus aurantia* (red scale) and *Lecanium oleæ* (black scale), now such great pests to the orange growers of California, found their way into the citrus orchards of that State, directly or indirectly, from the Australian acacias or some similar species of exotic trees, imported or planted for use or

ornament. The Australian acacias have long been popular in California, and many of these beautiful trees may be seen growing there in the towns and country places. In the same State, less than a dozen years ago, the inspection of a bushel or two of apples or pears would perhaps have resulted in finding one or two specimens of the larvæ of the codling moth (*Trypeta pomonella*, Walsh). Since that time the fruit growers have had to fight it as a pest, and have been put to great expense to cleanse their orchards of this and other injurious insects, the stock of which was incidentally introduced, as is generally believed, on trees from the East. In the climate of the west coast, which is particularly favorable to the development of this class of animal life, the increase of pestiferous insects has been surprisingly rapid.

The trade in plant seeds is enormous and extends throughout the entire world. The increase and spread of noxious plants is largely owing to their seeds being mixed with the seeds of desirable plants, and the weeds of one region thus become the weeds of another, remote from the original habitat. The May weed of the New Englander, *Anthemis cotula*, or European dog-fennel, has through the operations of nature and the incidental assistance of man, put a girdle around the earth. The *Chrysanthemum vulgare* is a pretty, but to the farmer an obnoxious cosmopolite, popularly known as white-weed and ox-eye daisy. Another plant pest, *Cnicus arvensis*, familiarly called Canada thistle, though of European origin, has spread it might be said to the uttermost bounds of the earth. So far as America is concerned, it, the latter country, has reciprocated by contributing the horse weed, *Erigeron canadensis*, to the pestiferous plant stock of Europe.

From mammalian, insect and vegetable forms, let us now briefly glance at molluscan species. The slowness of the snail's pace is proverbial. Yet we find that several species are widely dispersed, not by reason of their own means of locomotion, but as an incident of commercial intercourse. A species of slug, *Limax hewstowni*, Cp., has become quite common of late years in the grass plots and lawns of San Francisco and vicinity. There is good reason for regarding it as an incidental importation.

Both, or rather all of these are pests, the insect forms especially, as they entail a heavy burden upon an important industry. The slugs are a pest, though the damage done by them is trifling, insomuch that they are slimy and disagreeable, and therefore a nuisance. There are other molluscan forms, which in this connection are worthy of notice.

The common land snail of Europe, *Helix hortensis*, which annoys the gardeners of portions of the old world by eating the lettuce and other tender vegetables, is found on several of the islands along the Atlantic coast from Newfoundland to Cape Cod, and on the main land, plentifully at Gaspe, Canada East, along the St. Lawrence River, also in Vermont, Connecticut, etc., etc. Another land snail, *Helix aspersa*, one of the principal European species, and largely used in France and elsewhere on the Connecticut as an article of food, has become naturalized in the gardens of Charleston, S. C., and vicinity, where it has existed for fifty years; it has also been detected at New Orleans and Baton Rouge, La.; Portland, Me., Nova Scotia, etc. In addition to those named another well known land snail, *Stenogyra decollata*, is numerous in Charleston, S. C., where it has been living for many years. It is also found in Cuba and Brazil. I found it abundant in January, 1869, in Charleston, among the ruins caused by the civil war. These three species of mollusks, as before mentioned, are indigenes of Europe, and have been incidentally introduced through commerce into the portions of Eastern North America I have indicated.

By the same medium, one of our American species of pond snails has been transported to England. In November, 1869, the late Dr. Jeffreys announced the discovery of *Planorbis dilatatus*, in the Bolton and Gorton canals at Manchester. Suspecting that this American species had been introduced into the canals through the cotton mills, he wrote for information and learned that in one habitat, the waste from the first process or "blowing machine," was discharged close to that part of the canal where the *Planorbis* occurs. This little mollusk was doubtless conveyed in the raw cotton, either in the egg state or otherwise, from some point in the Southern States.

It is not necessary to enlarge by adding to the illustrations

above presented. I have submitted but a few, a very few, and the few submitted relate only to such forms as have maintained themselves, and increased their numbers and extended their distribution in the regions into which they have been incidentally placed. Of the species thus unintentionally transplanted, it will be noticed that they are generally obnoxious or pestiferous. Some of them are harmless, others seriously detrimental to human interests. Rarely a highly useful species is incidentally planted. We have, however, one interesting instance on the profitable side in the accidental planting of the soft-shelled or long-neck sand clam or mananose, *Mya arenaria*, of the Atlantic seaboard, in the waters of California. Soon after the completion of the Central Transcontinental Railway, the oyster dealers of California, many of whom have a large capital invested in the business, commenced the importation of small oysters, *Ostrea virginica*, from the Atlantic coast by the car load, for planting in San Francisco Bay, where they soon grow to a merchantable size. This was somewhere about 1872 or 1873. The small oysters were obtained in part from Newark Bay. Among and adhering to them was the spat of the clam, for in November, 1874, several specimens of *Mya* half or two-thirds adult size, were collected by Mr. Hemphill on the eastern shore of the bay where the oyster beds are. Since that time it has multiplied so wonderfully and the environment has proved so favorable, that it has spread in every direction and attains a large size. It is now the principal clam ; it has so monopolized the bay region that the indigenous forms that were previously sought for food, have become comparatively scarce, and the cockle, *Cardium corbis*, and the thin shell tellen, *Macoma nasuta*, once so abundant, are seldom seen on the market stalls and are not easily obtained. Outside the bay of San Francisco, the mananose (*Mya*) has either incidentally or intentionally been planted at Santa Cruz, at the northern end of Monterey Bay, and an intentional 'plant was made at Shoalwater Bay, Washington Territory, a few years ago, by Capt. Simpson, of San Francisco ; he informed me that it resulted in an abundance of this excellent clam.

As proof of the previous non-occurrence of *Mya arenaria* on the West coast ; it may be well to state that the shore from Cape

St. Lucas, northerly, has been explored by many competent naturalists at various times, extending back to nearly the beginning of the present century. Since the American occupation of California, commencing with 1849, several intelligent collectors have resided there, and others have visited the coast. It would have been impossible for so familiar a form, inhabiting, too, the easily accessible litoral zone, to have escaped detection : and corroborative of the above, we have the further evidence of the kitchen-middens or shell heaps of the aborigines, many of which have been examined by me without detecting any sign of this easy recognized species.

Washington, D. C.

TRANSPORTING FISH IN THE BRITISH ISLES.

BY W. V. COX.

The improved methods of refrigeration so extensively practiced in the meat and fish carrying trade of the United States, were not applied to those industries in England at the time of the International Fisheries Exhibition, London, 1883.

Even the old method of packing fish in boxes with ice for transporting purposes, was very defective, if we may judge by the condition of the fish when they arrived and the boxes were opened.

In the markets of London, I frequently saw whole boxes of fish that came from a comparatively short distance "packed in ice," that were spoiled and totally unfit for food. Very often the fish were discolored, and seldom were they very inviting in appearance. If it had not been that a fugitive piece of ice was occasionally discovered in the box with wet straw, there would scarcely have been a suspicion that there had been an attempt made to carry the fish in ice. It seems strange that there was such a lack of application of the well-known discoveries of preservation, not only in inland and local water transportation, but

in the markets themselves, when these methods are in such common use in ocean transit, whole cargoes of frozen meats, being daily brought to London from all quarters of the globe, even from New Zealand. Of the fish coming to London from adjoining waters, I found those that came by railway in a worse condition than those that came by water.

Aside from the more frequent handlings of railway-borne fish, the unwholesome condition of unsuitable cars had, doubtless, considerable to do with their deterioration. No objection could be made against many of the cars run on the special fish trains to London, for they were as good, perhaps, as any of an old and obsolete style ; but there were others for sanitary reasons that would have not been permitted to run were it not for a blunted and indifferent public sentiment. I shall not speak of these myself, but state the case through the words of others.

A witness before the corporation said : "You all think we load our fish in proper fish trucks. That is a great mistake. We load it nearly all in bullock trucks not cleaned out. Seven out of ten come in ordinary bullock trucks."

Another witness stated that "most of the fish comes in old cattle trucks, lime trucks, manure trucks, or any kind of truck that happens to be handy at the station. I have had plenty of barrels which had contracted so much filth that my man had to wash them before taking them on his back."

"Were you ever on the platform when a return Grimsby fish van was being shunted?" asks an English editor. "If you were, you are not likely to forget it." Having stood on the platform, candor, a love of truth, and an olfactory not over-sensitive either, will not permit us to disagree with this gentleman, for truly, as he says, "the stench is abominable, and there is little wonder that fish are condemned when they arrive at the markets."

Such a nauseating condition of things seems almost incredible to us Americans familiar with the cleanly-kept refrigerator cars fitted up by Chase, Ridgway and others, thousands of which bear fresh meat and fish to and from island points hundreds of miles distant, yea, even from ocean to ocean. But still more incredible is it that railways in the British Isles have not long since found it to their selfish interests, if not the public welfare, to

adopt some modern methods of transporting perishable objects.

How far behind the age, and how short sighted it proves them to be when we find an English paper asking, "Cannot science persuade the railroad companies or large smack owners, or merchants, to have suitable fish vans, refrigerating or ice vans?"

The exhibition did much to educate the English people on this subject, and toward its close, in October, 1883, the Fish League, (limited) of London, placed refrigerator cars, (Knott's patent) on the London & Northwestern Railway. The trial trip proved successful, when sixty baskets of fresh herring were brought from Wyck, in North Scotland, to London. They were sixty hours *en route*, the shipment moving at the rate of nine miles an hour.

From an English standpoint it seemed wonderful that the fish came 550 miles inland in good condition, and one of the papers stating that "they were as dry and sweet, and clear about the eyes, as though they had only been drawn up from the North Sea a short half hour or so before." These fresh herring, the first ever brought from North Scotland to London, retailed in market at from four to six cents a dozen.

The Fish League contemplated extending the system from various important fishing ports to the chief centers of population. Extortionate rates of the railways were found to be the chief obstacle the League had to encounter. It was plain that if the companies would not make concessions that the era of the refrigerator car was almost as remote as before, and the problem of cheap fish would not be solved in this way. Since 1883, I am informed there have been some concessions by the railway companies, but with true proverbial conservatism, there has been but little progress made in adopting that which has proven such a boon to all classes in all parts of America.

Washington, D. C.

THE MICHIGAN GRAYLING.

BY HERSCHEL WHITAKER.

The grayling (*Thymallus tricolor*) is found native to the waters of Michigan alone of all the States of the Union. Vague rumors from time to time have hinted at its presence in other waters, but the authenticity of such statements has never been verified. A few facts concerning the distribution of the grayling of Michigan, its habits and the experiments that have been made here looking to its artificial propagation, may not be devoid of interest to this Society.

The waters of Michigan in which it has its habitat, may be generally described as within the territory bounded on the south by 43:30, extending as far north as 45:30. The streams included within this territory discharge their waters into Lake Huron and Lake Michigan. An imaginary line drawn from the mouth of the Muskegon on the western border of the State to the mouth of the Au Sable on the east, will perhaps better indicate the southern limit of the grayling. The waters most famous as grayling streams, owing to their magnitude, accessibility and their popularity with sportsmen, are the Au Sable and the Manistee. The Hersey, the Pere Marquette, the Maple, the Pigeon, with their tributaries, and numerous other streams of less importance included within the boundaries already mentioned, are also fairly stocked with this fish. The Boardman, the Boyne and the Jordan were once famous resorts for sportsmen who angled for the grayling, but their glory as grayling streams has long since departed, the grayling having given way to the predacious and combative trout, yet now and then an occasional grayling is taken.

Although the subject has often been discussed by writers upon game fishes, allow me briefly to refer to the general character of this fish. To the sportsman who has always angled for trout and is unfamiliar with the habits of grayling, this fish will excite some surprise upon first acquaintance. Unlike the trout you are not likely to find him in pool and shady haunt, but on the swift ripple and shallow, hovering like the hawk in air. While

you are adroitly seeking with your trout-fisherman's experience, to reach some shaded pool where you should expect to find him if he were a trout, you suddenly find your fly taken most unexpectedly in open water, and you are taken somewhat at a disadvantage. Once securely hooked comes the beauty of the fight, and here the grayling differs most radically from the trout. Instead of seeking shelter by retreating to the deep pool or beneath some root, he will perhaps leap clear of the water from two to three or more times, and with a vicious shake of the head seek to free himself from the hook. When landed you try in vain to determine which has the superiority, the grayling or the trout, but you finally conclude that you have forgotten exactly how the trout acts when hooked, and if you are a philosopher you inwardly argue that it is such a close question, you will leave its determination to such time as you shall catch your next trout.

The large dorsal fin is the distinguishing characteristic of the grayling. In repose the fin lies folded upon its back, but in a state of activity or when excited, the anterior portion becomes rigid, and the posterior portion waves like a banner in the air. When freshly taken from the water the dorsal fin is iridescent and its variegated coloring is gorgeously beautiful and vivid. The fish itself is covered with small light steely gray colored scales, and above the median line has a few faint brown mottlings about the size of the head of a pin. Its head is quite small and the general contour of its body is slim and graceful. A faint odor is discernible resembling the wild thyme, hence its name, *Thymallus.*

As early as the year 1854 or 1855, the grayling was first called to the attention of local scientists in Michigan, by Mr. Wright Coffinbury, a gentleman in the employ of the general government, who was then making surveys of the wilderness lying adjacent to the Muskegon and Hersey rivers. At this time the grayling was plentiful in all these streams, and afforded the surveyor, explorer and hunter a grateful change from pork and hardtack, and the fish was known among them as "Michigan trout." Mr. Coffinbury had the grayling especially called to his attention, as he busied himself during his leisure hours in an

attempted classification of the fish found in the Muskegon and tributary waters, and as I have before mentioned he was instrumental in calling local attention to the grayling. Later on and about the year 1885 or '56, Dr. Parker of Grand Rapids, Michigan, (now president of the Michigan Fish Commission), succeeded in procuring a specimen of the grayling, beautifully preserved in homely salt and wrapped carefully in a newspaper, minus a few fins, and of course almost devoid of its natural color, and after a careful study of the specimen and a comparison with a cut of the English grayling, and a description of the same, he pronounced it a true *Thymallus*, and in a paper read before the local scientific society of Grand Rapids, named it *Thymallus michiganensis*, a patronymic by which it was known locally for some years ; in fact up to the time that a specimen was sent by Prof. Miles to Prof. Cope in 1864. Specimens subsequently submitted to Prof. Agassiz through the efforts of Dr. D. H. Fitzhugh, of Bay City, Michigan, who is beyond question the greatest authority on grayling in the country, were classified by that eminent scientist, and determined beyond question, to be the grayling.

During the period to which I have referred, the streams embraced within the territory already indicated were swarming with this beautiful fish. So plentiful were they for many years that the settlers were accustomed during the spawning period to come to the dam, at or near the site of the present village of Hersey, and capture them with baskets, carrying them away by the wagon load. There are many people yet living in that vicinity who can vouch for the truth of this statement, were it necessary, but I think I can safely presume that the courtesy of gentlemen who are interested in the propagation of fish and the fishing industries and interests, will scarcely require the fortifi cation of this statement by affidavit.

It would seem unaccountable that this state of things having once existed, that in late years the grayling should have so rapidly disappeared from these streams ; yet the fact remains that many of the streams that once knew them now know them no more. This is notably true of such noble staeams as the Jordan, the Boyne and the Boardman. From those streams which flow

to and discharge their waters on the extreme northern coast of the Lower Peninsula the grayling have entirely disappeared, although now and then an occasional straggler may be found. The cause of this depletion is, however, directly traceable to the lumberman and the trout. The grayling cannot successfully run the gauntlet of log-running and the vicious attacks of the trout, who loves the dainty and succulent fry and the youngster grayling, and overcomes them both. It is a fact that until within the last thirty or forty years, brook trout were unknown in the northern streams of Michigan, while the streams of the Upper Peninsula, discharging their waters into Lake Michigan, are stocked almost exclusively with the trout. The theory advanced and generally accepted by those familiar with the facts, is that a migration of the trout has taken place from the streams emptying their waters into Lakes Michigan and Huron to those grayling steams. There is much reason, it would seem, for this argument. It is a peculiar fact that the waters of the Maple River, lying in the extreme northern portion of the Lower Peninsula, are well stocked with grayling. This stream flows in a southerly course, which is contrary to the direction of most of the streams in that portion of the State, discharging its waters into Burt Lake, one of the larger lakes of the "Inland Chain," which extends from Cheboygan to Petoskey, and is famous for its bass and pike fishing. To carry the argument to its seemingly just conclusion, it might be inferred with reason that the trout would be shy of entering upon waters in the possession of these voracious and predatory fish, and the probabilities are very strongly in favor of the theory that if they did enter upon such territory and lie down peaceably together, it would be that peaceful quietness of the trout lying down inside the bass or pike. On the other hand, the Maple is a swift, brawling, grayling stream ; its waters are cold, a peculiarity of all grayling streams, offering no inducement to the bass or pike to take up their abode within its borders, and the consequence is that the grayling remains in full possession, having the advantage of the watchfulness of vigilant sentinels standing guard at the mouth of the river to prevent the entrance of the trout. The other streams I have mentioned discharge their waters either directly

into the Great Lakes or into tributary waters which are not infested with bass or pike.

Upon the formation of the Michigan Fish Commission the merits of the grayling were recognized, and the fact that it was a fish peculiar to Michigan, appealed strongly to the Board to investigate its possibilities of artificial propagation. Lack of funds and the knowledge that the commercial fish of the State demanded its first attention, compelled the Board to postpone attempts to solve this question. Not until the year 1877, was an attempt made to experiment in this direction and test the possibilities of success. In the spring of that year a camp was established upon the headwaters of the Manistee, and an effort was made to secure a stock of eggs, to be transported from the camp to the hatching station Owing to the lateness of the season, the spawning period having passed, this attempt failed of any result, and the expedition returned with no further light. This party reached the Manistee April 14th. The following year an earlier start was made, the force arriving at Manistee, March 30th, but again found themselves too late, the fish having again passed the spawning period. A few fish were obtained which yielded a very small quantity of eggs and milt, but the eggs were imperfectly impregnated, the fry produced died early, and in the langauge of the superintendent, "much lamented." Before leaving the stream, however, it was decided to procure as many adult fish as possible, convey them to the station, and make the attempt to handle the fish in the succeeding year when the proper period should arrive. A number of fish were procured, but for unexplained causes no success was obtained. Adult fish have been obtained at three different times with the same object in view, but up to this time with no satisfactory results. The difficulties surrounding the taking of the grayling during the spawning period are very great. The fish spawn in about February and March, perhaps even earlier. The rivers in which they abound are remote from civilization, the roads almost impassable, and the streams filled with logs and ice, rendering it exceedingly difficult to procure the necessary fish. Experience has proven very clearly that the grayling will not stand domestication or confinement in ponds in which trout may be successfully

carried. Two years ago a number of adult grayling were procured by the Michigan Commission, and placed in the trout ponds of Paris. Out of the number not a single fish has ever spawned or showed the slightest inclination to do so. They have gradually died, and there are now but a very few remaining. The same care and attention has been given the grayling in these ponds that is ordinarily given to trout.

About the year 1878, Mr. Ira Metcalf, of Battle Creek, Mich., made some attempts at artificial propagation of the grayling, and claims to have been successful in raising a small amount of fry.

An instance illustrating the prolific character of the grayling, Mr. George H. Jerome, formerly superintendent of the Commission, states in his report that in transporting the first grayling taken to the station from the Manistee, it was observed by the men having charge of the fish while *in transitu*, that there was a fully ripe spawner in one of the cans; that she was removed and the eggs taken, but there being no milter with which to fertilize the ova, they were lost; that the eggs after being taken were counted by two reliable persons, and there were found to be 3,555 fully developed perfect eggs. The fish after being stripped weighed exactly 9 oz. This shows beyond question that the grayling is much more prolific than the trout, and under favorable circumstances good results should certainly be obtained.

The Michigan Commission has within the last year acquired the ownership of a fine spring stream upon property adjoining its trout station, to which the grayling had been natural, one or two having been taken in the stream within a year. This property affords opportunity for extended experiments looking to the solution of the question of whether the grayling may be successfully propagated. Arrangements are now being made to secure an ample supply of stock fish, which will be held in this stream in such a manner that the confinement will be felt as little as possible consistent with control. As far as possible the natural conditions of the stream will be preserved; pool and shallow, light and shade. At the same time care will be taken to afford an opportunity for experiments which may from time

to time suggest themselves, based on present knowledge, and such information as may be obtained by a careful observation of their habits. The experiments will extend over a sufficient period of time, and be followed up by earnest endeavor, until it shall be definitely determined whether successful propagation of the grayling can be carried out.

Detroit, Mich.

Mr. May.—I notice that Mr. Whitaker credits Mr. Metcalf with hatching grayling in 1878. I have seen in Prof. Goode's "Epochs in Fish Culture," that Fred Mather hatched the first grayling in 1874, just four years previous to Mr. Metcalf.

Mr. Clark.—I think the grayling is the easiest fish to propagate and handle of any fish we had anything to do with, after we get the fish. Mr. Whitaker doesn't say this in his paper, but I will say that if a person can get the fish on the stream they can get five hundred thousand fish, which they can handle for one quarter of the cost of brook trout.

Mr. Fairbank.—How long are they in hatching?

Mr. Clark.—From seventeen to twenty-five days. They are easy to handle. The fish are easy to take care of after they are hatched, and you can grow a greater per cent. of them than you can of trout.

A Member.—Don't they require much cooler water.

Mr. Clark.—I think you can put trout in a natural stream of warmer water than you can the grayling. I haven't tried the experiments on that. I got about twenty-five thousand eggs last spring from six or eight fish. A fish that weighed one and a quarter pounds we took five thousand two hundred eggs from. All we had to do was to get the fish, and you give me a thousand graylings, and if I don't take you over a million eggs I will miss my guess.

Mr. Fairbank.—It is difficult to get the fish at that season of the year.

Mr. Clark.—It is difficult to get them, because the streams are fished out. The streams are not high, not at that time. You

want to be on the ground on the first of March, and you may not get any eggs until the 15th of April. I am speaking of hatching in seventeen to twenty-five days, that is, in water that is fifty to fifty-eight degrees.

Mr. FAIRBANK.—The water in those streams would be cooler at that time.

Mr. CLARK.—Yes, the water is cooler, and I think that the driving of logs is cleaning the grayling streams out of those fish in the State of Michigan. I think it is more from that cause than it from any other, either fish or fisherman.

Mr. TOMLIN.—Even granting what Mr. Clark says, notwithstanding the survival of the fittest, the grayling is being extinguished. In my mind there is no question about it. You take Sweden, Norway, Japan, Germany, Italy, France and England and you will find the trout and grayling side by side. You put the trout into any stream where the grayling is and in a little while the trout will clean them out. I have fished the streams that Mr. Whitaker has spoken of in his paper. Years ago I fished the Jordan, Pine River, the Pigeon, and the Sturgeon, and later years the Muskegon River. When I first went to the Jordan, way back in 1860, there used to be a considerable number of grayling. I got to paying frequent visits to Michigan, and I love it as much as my own State for its beauty. I found out that the history of the trout was a far more recent one than I had supposed. I had always imagined that trout was to be found in certain streams. There was an old man on the Jordan, long enough before Pine River was cleared out, who well remembers the coming in of the trout. He says when he first went there to fish—he was an old Methodist itinerant preacher I think—he used to catch one trout perhaps to ten graylings; in five years from that time they were equal. Well now, we know from the structural appearance of the fish, that the grayling doesn't stand the shadow of a chance beside our trout. You take for instance a body of water and put in trout and small black bass, and the trout will clean the bass out. They will chew him up, eat his tail and fins off, and by and by there isn't a bass there at all. This is the way the American trout are

cleaning out our grayling. So far as the two fish are concerned, I say if we can't have but one, let us have the trout. I have fished for them both carefully; I have waded up to my waist when I have been so blinded with mosquito and fly bites, that I have scarcely been able to see, yet I have kept on fishing, and my conscience never accused me of having caught them in large numbers. I don't think I ever caught over twenty at a time. Mr. Whitaker doesn't make any difference in his paper about the appearance of the grayling. You take the grayling found in the Sturgeon and Pigeon, and flowing through into the Cheboygan, you will find them very different in appearance from those on the west side of Michigan. You take the grayling found in Pine River flowing into the Manistee, and the Manistee itself, and compare them with rivers flowing into Lake Huron, and the western grayling are by far the smallest. The eastern trout, those in Pigeon River and Sturgeon River, sometimes weigh three pounds, whereas on the other side we have never got them weighing more than a pound and a half.

Mr. MATHER.—Trout and grayling have lived together in the streams of England and Germany for centuries. The trout were the brown trout, however, *S. Fario*, and not our American trout or charr, *S. fontinalis*, but I cannot think the latter more predaceous than the former. Nor do I understand why certain grayling streams of Michigan were destitute of trout, and were full of grayling, because the lakes into which these streams empty contain trout which go into neighboring brooks. If any one can account for this we would like to hear him. If there are no further remarks, however, it might be well for us to adjourn.

On motion, duly seconded, the Convention here adjourned to attend the Citrus Fair at Battery D Armory, to meet again at three o'clock P. M.

AFTERNOON SESSION.

WEDNESDAY, APRIL 14th, 3 P. M.

The meeting was called to order by the Chairman, Dr. Hudson, and the Secretary read the following :

HISTORY OF THE ICED FISH AND FROZEN FISH TRADE OF THE UNITED STATES.

BY A. HOWARD CLARK.

The iced fish trade of the United States began about the year 1842. Prior to that date the inland trade in fresh fish was very limited, and could be carried on only in the winter months. In 1845 the fishing vessels of New England began to carry ice for keeping the catch fresh. Care was at first taken that the ice be kept separate from the fish, being placed in a corner of the hold. It was soon found, however, that packing the fish in crushed ice did not materially injure them, and this method was soon in general use on all the vessels, and largely superseded the trade in live fish north of Cape Cod. For many years it was thought impossible to transport fish inland, even if packed in ice, and it was not until 1859 or 1860, that Gloucester dealers could be induced to try the experiment of sending fish in ice to Boston and New York. Old sugar boxes were used for packing, and as the experiment was perfectly successful, a large trade was quickly developed, and iced fish were sent west as far as Minnesota and south to St. Louis, or even to more distant markets.

For ten years or more prior to 1842, Boston and Gloucester dealers had carried on a trade of frozen fish during the winter and early spring, sending the fish by teams inland as far as Albany and Montreal; but as warm weather advanced the frozen fish gave place to dry and pickled fish. In the winter of 1854 an enterprising Gloucester fisherman tried the experiment of bringing frozen herring, cod and halibut from Newfoundland to Gloucester, where the herring were sold to the cod fishermen

to be used for bait. From that experiment began a rapidly increasing trade in frozen herring from Newfoundland and New-Brunswick for the supply of the Georges codfishermen, and this bait is still the principal kind used by the fleets fishing from Gloucester in winter. The frozen herring also found a ready market in Boston, New York and other places as a cheap food supply. These fish have always been frozen by simple exposure in the open air, a warm spell interfering with the work. After freezing they are packed in bulk in the vessel's hold, snow being often mixed with them.

In Russia and other cold countries of Europe and Asia, for very many years there has been a trade in frozen fish, and other animal foods. In Thibet, as early as the year 1806, the flesh of animals was preserved by frost drying—not simply freezing—and in this condition it would keep in good condition for many months. Meat thus preserved did not have a raw appearance, but in color resembled that which had been well boiled, the ruddiness being removed by the intense cold.

Thus far I have spoken only of iced fish and of fish frozen by natural means. The first definite record we have of fish frozen by artificial method is the patent (No. 31,736) granted in March, 1861, to Enoch Piper, of Camden, Maine. It is described as a method of preserving fish or other articles in a close chamber by means of a freezing mixture, having no contact with the atmosphere of the preserving chamber. Mr. Piper states that the most important application of his invention is for the preservation of salmon, which had heretofore been preserved in a fresh condition only by being packed in barrels with crushed ice, which in melting had moistened and injured the fish. The ice, he said, could not keep them more than a month, whereas by the new method they could be kept in good order for years, if need be. The apparatus used by Mr. Piper is described as a box in which the fish are placed in small quantities on a rack, this box being surrounded by a packing of charcoal or other non-conducting material. Metallic pans filled with ice and salt are then set over the fish, and a cover shut over the box. About twenty-four hours is needed to complete the freezing, the ice and salt being renewed once in twelve hours. The fish

are then removed to be packed in the storage or preserving box. If desired, the fish may be coated with ice by immersion in iced water; they may then be wrapped in cloth and a second coating of ice applied, or they may be coated with gum-arabic, gutta-percha, or other material, to exclude the air and to prevent the juices from escaping by evaporation. The storage box is a double one, the inner one without a cover; the space between the sides and bottoms of the two being filled with charcoal or other non-conductor. Metallic tubes for the freezing mixture pass through the cover of the outer box and through the bottoms of both boxes, connecting with a small pipe to carry off the brine. The combined area of the tubes is required to be about one-fifth of the area of the inner box, in order to keep the temperature below the freezing-point.

Numerous and complex methods of freezing fish have been devised since Mr. Piper obtained his patent, but the simplest methods are perhaps as effective, and are surely more economical than the expensive machinery sometimes used.

In 1869 Mr. William Davis, of Detroit, patented a freezing pan for fish, which he describes as a thin sheet metal pan or box in two sections or parts, one made to slide over the other, the object being to place the fish or meat in one part of the box, and to slide the cover on to or in contact with the freezing mixture. The pans are packed on top of one another in a freezing box with iced salt over and around them. By this method from thirty to fifty minutes is said to be sufficient to complete the freezing, when the fish may be taken from the pans and stored in a keeping chamber, where the temperature is constant at six to ten degrees below the freezing point.

In 1869, Mr. Davis also patented a preserving chamber, which may be a room, box or chamber of any desired form. It has two walls with the intervening space filled with a non-conducting material. Within this are metal walls of less length than the outside walls, so that between the two a freezing mixture may be placed. Entrance is obtained through the top or side by closely fitting doors or hatches. Other methods of freezing fish have been patented, such as making a series of seven circular pans of a size to fit in a barrel, and of putting the fish in

rubber bags while they are being frozen. In 1880, Mr. D. W. Davis patented a method of packing fish in finely crushed ice in a barrel and freezing the mass solid, the fish being so stowed as not to come in contact with each other.

Freezing pans, with or without covers, are now in common use in most of the fishing centers of the Great Lakes, as also in some Eastern markets. In Boston, New York and at other points large buildings are devoted to the freezing and storage of bluefish, salmon and other species. The large species are frozen by hanging them in the freezing room or by ranging them on shelves. The improved systems of refrigerator cars and steamers render it feasible to transport frozen fish to any part of the United States, or to foreign countries whenever the trade may require.

Washington, D. C.

Secretary MATHER.—Mr. Chairman and gentlemen, I would like to say a little something not laid down in the programme nor embodied in a regular paper, and that is about work of the United States Fish Commission in its experiments of stocking the Hudson with salmon. For the past three years I have had the hatchery under my charge on Long Island, and been hatching some sea salmon from the Penobscot for Prof. Baird. They have been placed mainly in the Hudson, and some few in the Salmon river, in the State of New York, which empties into Lake Ontario, not the Salmon river entering the St. Lawrence, and also last year in the Oswego river. We have made some effort to find out if there was any prospect of getting evidence of the success or failure of these plans. The fish were taken away to the headwaters of the Hudson, and deposited in trout streams there where they would find food, which they would not find suitable for young fish in the main body of the river. It has been Prof. Baird's idea that the Hudson never was a salmon stream naturally, because of mechanical obstacles, such as the falls at Cohoes, which prevented the ascent to the tributaries of the Mohawk, and Baker's Falls on the upper Hudson, which prevented their ascent any further in that way, and any fish which entered the river before the white man put up his dams

were debarred from the spawning grounds; therefore we have deposited the young fish there. Last summer I wrote a letter to Mr. A. N. Cheney, of Glens Falls, a member of this Association and a gentleman who takes a very great interest in anything of this kind, asking him if it would be possible to employ some man there to examine those trout streams, and see if there was any trace of those young fish left, and the following letter from him, tells of the success of last year's plant.

GLENS FALLS, N. Y., Oct. 9, 1885.—*Mr. E. G. Blackford*—Dear Sir: As requested in your letter of July 2, I send you to-day by National Express specimens of the young salmon from Clendon brook. I was absent when your letter came and have been home very little since, which is the cause of the delay. I told Mr. Mather that I would certainly get them before winter. I engaged a man to take the fish, but he was not successful, owing to high water. Yesterday I went to the brook with a friend, Mr. W. D. Cleveland, of Houston, Tex., and in a short time caught the number I send. You will, perhaps, remember that Mr. Mather sent me 40,000 salmon fry on May 21, 1884, and 60,000 salmon fry and 150 yearlings April 29, 1885, from Cold Spring Harbor, and all were deposited in Clendon brook, a tributary of the Hudson. The Clendon was once a famous trout stream, yielding trout of four pounds and upward, and still there are some few baskets of small fish taken from it. Yesterday the stream seemed fairly alive with salmon for a mile, and residents tell me that this is the case its entire length. As the trout were attending to their domestic duties up stream the brook was given over to the salmon. They were in the deep holes and at the foot of the riffs, but everywhere in numbers. There seemed to be two distinct sizes, one four to six inches long, the other two to three inches long. With the exception of a few chubs, silver chubs or fall fish, *S. bullaris*, I found no other fish than salmon in the stream. One bright-colored male salmon as I took him from the brook discharged milt from the pressure of my hand. This particular fish I caught in swift water where it ran over gravel. I hope Brother Mather will have an opportunity to interview these young things that were graduated from his University at Cold Spring Harbor before they are sent to Prof. Baird. It would have been an easy matter to catch a hundred yearlings during the time I was at the brook, and in their eagerness to take the lure they jumped clear above the water. After catching the first salmon, Mr. Cleveland exclaimed: "If that beggar weighed thirty-two pounds" (he had in mind a salmon caught

this summer by Mr. H. P. Wells) "and game in proportion, and I had fought and killed him, it would have taken just six months to recover from the excitement." The Clendon brook is posted its entire length and the people are interested in protecting the fry that have been deposited therein by the United States Fish Commission. I trust that you will receive the salmon in good order. I send but one of the smaller size, as the other and larger salmon gave no kind of show to take the hook. A. N. CHENEY.

These salmon were seven or eight inches long, showing that they had lived there, and were about ready to go to sea that fall.

Mr. FAIRBANK.—Mr. President and gentlemen, I thought it might be of interest to say a word or two, to the gentlemen here in relation to the matter of planting fish in waters where they are not indigenous. We have made very great strides in artificial propagation of fish, and have mastered all the difficulties of hatching fish, procuring the eggs, hatching and obtaining the young fry, and a great deal of work and a great deal of money has been expended in planting fish in various waters in all of the States. We started off with a degree of enthusiasm eight or ten years ago, that was worthy of a better outcome than we have had, but it was done with more zeal than wisdom I think. We have planted shad, for instance, in the Calumet river here, which empties into Lake Michigan, and we have planted trout in the Kankakee river and brook trout in the streams of Iowa, and lake salmon in all the little lakes in Michigan and Illinois, and wherever there was a little stream we thought at that time all we had to do was to hatch the fish and put the young fry in there and we would have an abundance of fish. It is needless to say, at least I have not heard of any instance where any of these efforts have been successful. I was anxious to demonstrate the fact, and I decided to make an experiment in Lake Geneva, Wisconsin, which I did on a large enough scale to demonstrate thoroughly whether it was practicable. Lake Geneva is a lake about eight miles long and from half a mile to three miles wide. It is a very pure body of water, as blue as Lake Michigan. It is 185 feet deep, I have found in some places, but it averages 100 feet deep all over it, bold shores and very clean.

There is not a bulrush or a lilly pad in it, and in every way is particularly adapted to the salmon-trout, because it seemed in all its characteristics just like the small lakes of New York State in which the salmon trout are indigeneous—Canandaigua lake, Cayuga lake, and several of the lakes there. Not feeling sure about it, I wrote to Mr. Seth Green, who was an old friend of mine, to come out and spend a week with me, which he did, because I wanted his judgment in the matter; and we sounded the lake and found the depth of the water and we dredged the bottom. We caught all the small varieties of fish to see what food there was for the salmon trout. Lake Geneva is somewhat celebrated for abounding in the small fish known as the cisco. There are in that lake and one or two other small lakes of Wisconsin, and they are there in great abundance, living in deep water. The cisco is the natural food of the lake trout, and we therefore very naturally came to the conclusion that Lake Geneva was particularly adapted, if any lake on the face of the earth was, for planting and growing the Mackinaw trout, or lake trout. So I built a hatching house and I employed one of Mr. Green's men, Mr. Welcher, who was afterward superintendent of the Wisconsin fish hatching establishment, and went to work. The first year I bought the eggs from the New York State Commission, 200,000, and after that Mr. Welcher went every fall to Lake Michigan and took the supply of eggs. I have laid in about 590,000 each winter, and I pursued that faithfully and put in about 500,000 good, healthy fry in the lake every spring for five years; but I have never seen, and no one else, as near as I can find out, has ever seen the shadow or sign of a salmon trout in Lake Geneva, large or small.

A MEMBER.—How deep is the water?

Mr. FAIRBANK.—About 150 feet or an average of 100ft.

QUESTION.—And what is the temperature?

Mr. FAIRBANK.—It is a cold lake. I don't know.

The SECRETARY.—They ought to be there, Mr. Fairbank.

Mr. FAIRBANK.—Well, they are not there. Mr. Green, said "They are there, but you don't know how to fish for them. They

are in deep water." "Well," I said, "you come out and spend another week with me and we will fish for them." He said he was not able to come, but replied, "I will send my son out." I offered to pay all his expenses, and his son came out. I think that was two years ago, and he spent a week with me, and we spent the week fishing faithfully in the deep water with Mr. Green's methods, with a heavy sinker and leaders, and we fished the lake thoroughly, and Mr. Welcher came down with some gill nets—that was three years ago. We set gill nets across the lake in four or five different places, and followed that up for a week, and we never took or saw one sign of a salmon trout. Now, the reason of it is this, and that is the reason I call the attention of you gentlemen to it. It is a subject we have got to look at fairly, and it is the main thing in planting fish, and that is, what food is there in the waters where you propose to plant the fish for the young fish or fry? Salmon trout would live in Lake Geneva if they could come to maturity. The cisco is there in great abundance, and furnish a most excellent and natural food—the fish that they live on in Lake Michigan, but in looking at it, I was satisfied that all the young fish died. The fry starved to death because their food was not there.

Now, in looking at it you will see what the trouble is. The salmon trout breed in the Great Lakes wherever there is a reef, and there you catch them in three, four, or five hundred feet of water, or less, wherever there are extensive reefs of rock, there the gill nets are set and there the salmon trout are taken. Here are the Racine reefs, you sail over those reefs any time in the summer and throw out a trolling line and you take salmon trout. My theory of it is that on the face of that rock there is some animal life, animalculæ, that the young fish stick their noses in and feed on until they are old enough to eat other fish. Lake Geneva has no reefs of rock. Where there are stones at all it is a boulder bottom, or it is a mud bottom, earth and clay covered largely with leaves. It is surrounded to a great extent with timber and the leaves blow in every year. You try it and you will find on the bottom of Lake Geneva to be a layer of dead leaves, so there is evidently nothing there for the young fry to feed upon and the fry have all died, and that has been the

case in hundreds of other instances. I have sent them to Crystal lake. Mr. Dole who lives there is a friend of mine, and I have sent several hundred thousands for two or three years. I always gave him a lot to put in there. That is a small deep lake of perhaps three or four thousand acres, very pure water, and very clear, but there never has been a young fish seen, and I think it is money and work thrown away, and that it is utterly useless to hatch fish and put them in waters unless we know to a certainty that the food for the young fry is there. I made still another experiment in the same line by going into one of the neighboring lakes near by in Wisconsin, and taking a large amount of the spawn of the wall-eyed pike, I brought those down and hatched millions of them, and put them into Lake Geneva, and there never has been a wall-eyed pike seen there. Evidently there is nothing for those young fish to live upon. They breed and live and thrive where all the conditions are right for them, or in trout lakes where they are indigenous and there is something for the young fish to live upon. You may take the fry and put them into waters where there is no food for the young fish, and you will never have any result. This is a thing we might as well look in the face and understand that it is useless work. Now, see the work of the Iowa Commission, and they did a great deal, they took a great deal of spawn, salmon trout, I don't know where they deposited them—all over Iowa—but I have yet to learn that one has appeared. The same way I did with whitefish. I took about an equal number of whitefish as lake-trout, taking the spawn the same time of year and hatched about as many. I suppose I put into Lake Geneva 2,500,000, both of whitefish and lake trout. I was determined to make the experiment thorough enough to demonstrate that one question, whether these small lakes could be stocked with the better classes of food fishes where they were not indigenous to the waters. I knew that of course by putting a few thousand in a lake occasionally, or every year, five to ten or twenty thousand, was not enough to demonstrate it. They could easily be destroyed ; but by putting enough in, piling them in year after year, it would demonstrate it, and I spent ten or twelve thousand dollars in the experiment. I think this is a question that is very vital for us

to consider in our work hereafter—what there is in the waters where we propose to put fish for the young to live upon, and I apprehend there is not much to be gained in trying to plant fish in waters where they are not indigenous, or where they have not been some time. I also procured from Professor Baird, and hatched, perhaps half a million of California salmon the same seasons that I was hatching the others, which I deposited in the lake; but there is a little stream entering Lake Geneva—the lake is fed by springs. There is really no inlet to it except the springs around it, but at the upper end of the lake there is about a mile of low land, and the springs running down through make a little creek. I deposited the young California salmon in those little streams, little springs, and they ran down into this creek. Some of them I kept—perhaps fifty to one hundred thousand, about half of the amount I hatched, I kept from the streams until they were yearlings, and then turned them out, and we have taken occasionally a California salmon, but they are not at all plenty. For the last two years there has not been any taken. Three years ago a boy took one, a very fine fish, which weighed twelve and three quarter pounds, as handsome a salmon as I ever saw anywhere—showing that salt doesn't enter into the question at all as to the life of the salmon; that they will grow just as well in fresh water as in salt, if they have enough to eat. There is an abundance of food there, and the California salmon are a very hardy fish. I have no doubt if I had put as many California salmon into Lake Geneva as I did salmon trout, that we would had more of a result from it, still I don't apprehend that they would do much. I think a lake of that size and purity of water, and with all the food there for the maturing of fish, the California salmon might be made to flourish there if we had two or three miles of good gravel bottom stream in which they could spawn. I found in this little stream which runs up through the marshy meadow, very low ground—it is only a small stream, and the bottom is mud and the water is very cold but sluggish—I found in there one day four or five large salmon that would run 8 to 10 lbs., splashing around up in there—it was evidently their spawning season—looking for a place to spawn; but if they did lay their eggs they sank down in the mud and were

lost. There is no place there for them to hatch. I couldn't get any spawning ground for them. I also made an experiment in brook trout in these little streams, springs around those hills, and in this creek running down there, and established a fish farm up there, quite a trout pond, and stocked this little stream. This is eminently successful, because in the stream, in the weeds and growth in the bottom they are alive with the natural food of the brook trout, the little fresh-water shrimp, and now that mile and a half of stream running through this marsh is full of brook trout, as fine trout as I ever saw. In fact, I never saw fatter and finer brook trout than I find in there. I can go in there any time and take twenty-five or thirty trout in an hour or two. That experiment has been eminently successful, because the food is there for the fish. I thought I would give you gentlemen the benefit of my experience. I have never written anything about it, because it was a good deal of a question in my mind whether I ought to do it, and whether I ought to discourage the attempts that might be made; but I am so thoroughly satisfied that it is utterly useless that I think it should be made public.

Mr. DUNNING.—Mr. Chairman, I would agree with Mr. Fairbank in regard to Geneva Lake. He has taken a great deal of pains in stocking this lake, and it is as beautiful a lake as you ever saw in your life, and it is true, as he says—I have been there—that it has bold shores, deep water, and it would seem as though it was the most perfect place that ever was made for lake trout, but it is also true that they are not there. I am intimate with Mr. Fairbank and know about this matter, and there was no success whatever in the experiment, and it was very discouraging. Mr. Fairbank has done more to stock the inland lakes than any man I know of in the country, but I am satisfied, and I think Mr. Fairbank is, that is not the fault of the water, but it is the want of fish food. Now, Mr. Forbes in this State Professor Forbes, told me, in a conversation with him at our place in Madison, we had a great epidemic among our fish there the summer we was there, and he came there to investigate it, the perch died by the hundreds of thousands, and when he was

there we were talking about this same thing, and we dredged in our lakes to find the fish food, to see of what it was composed, to see if that was the cause of the epidemic in the fish. In the conversation he said to me, "Mr. Dunning I find in dredging in one haul more fish food than I would in Lake Geneva." It is mere nothing there, and the cause of the fish not doing any better I think is for the want of the food. Now, Mr. Fairbank, in the lake you speak of, you will find your fishing is rather crude for a body of water as large as that.

Mr. FAIRBANK.—There is good black bass fishing there.

Mr. DUNNING.—They are not as plenty as they should be and they lack food, and it is a lack of the food more than anything else.

Mr. FAIRBANK.—Oh, there is an abundance of food for the black bass, and for the other fish that are indigenous to the place.

Mr. DUNNING.—Now, in our lakes, Madison—we are surrounded by lakes there, we have had the lake trout annually, and they were put in. We got discouraged because they were put in in unlimited quantities and we didn't see any result, but we continued to put them in and they began to show themselves. A year ago last season, and this last season, and this winter they have been caught in quite good numbers, because people have learned to know how to fish for them. There have been a great many of these fish caught by people who didn't know what they were and they put them back, supposing they were dogfish, not being a fish they had been in the habit of seeing in our waters. Last fall during the spawning season of the trout, I took as many as five, that were partially digested from the stomach of a pickerel, from half a pound to nearly a pound. I took five. Now I account for that in this way. The trout were spawning at the time and the fish taking advantage of it took them.

Mr. FAIRBANK.—Have the fishermen taken any salmon trout of any size in your lakes?

Mr. DUNNING.—Oh, yes, weighing 3 lbs. to 3½ lbs.

Mr. FAIRBANK.—That is very encouraging, but your lakes

there bear out what I said. I think you have some lime formation and rocks.

Mr. DUNNING.—Yes, and some sandbanks. So I want the convention, as well as Mr. Fairbank, to think that Wisconsin inland lakes will produce fish—that is, the trout. There is no question about it.

Mr. FAIRBANK.—I have no doubt there are lakes where the food will be found. As I say, you find a lake where the proper stone formation exists, and you will undoubtedly find food for them ; but I think in the majority of the small lakes it would be utterly useless to put lake trout in them. I have never heard what the success was there at the Madison lakes. I knew something had been done there, but not the result. So if you have succeeded there you ought to go on and put in a very large amount of them every year.

Mr. DUNNING.—As remarked, it requires different fishing to fish for the lake trout than for the salmon.

Mr. FAIRBANK.—Yes, you have got to fish for them in deep water.

Mr. MATHER.—Mr. President, there is one thing that strikes me that is a little singular about Geneva Lake, and that is this, as I understand it, the food of all these young fishes belonging to the salmon family, including the brook trout, the lake trout, etc., which are all grouped in one family, there are only three classes of food which they feed upon ; one is the small crustaceans, another is the insects and flies on the surface, and the third is the larvæ of those flies and worms in the water, and they all feed upon that class of food, and if there is food in Geneva lake for the brook trout and for the California salmon, I do not know why the lake trout should not be found there also.

Mr. FAIRBANK.—The brook trout and the California salmon were put into this little stream up above, and there is where they found their food. There is insect life of course that the cisco feeds on. The young of the cisco find their food there. I don't know what it is.

Mr. MATHER.—It rather surprises me that there is food for all these and none for the lake trout.

Mr. TOMLIN.—Within a few miles of Duluth some years ago, some very wise men petitioned for the deposit of two hundred thousand of these salmon trout, just as Mr. Fairbank speaks of seven years ago. Now, I have been up to the lake several times and fished there, especially to see if there was any chance of getting these fish, and I was puzzled beyond my comprehension to understand why in seven years there had not any of them turned up. I thought surely in that seven years there would have been some young ones taken. As Mr. Mather said, I think the salmon family live all the way through on the same kind of food, and if there was food for the brook trout there would be for the salmon trout. Now, after the first plant of two hundred and fifty thousand was put in, the next year they put in another plant of two hundred and fifty thousand, so there has been five hundred thousand put in there. This lake I speak of has all the properties of a good lake for fish, except the limestone formation. It is boulders there, but any quantity of lily-pads and what are called fresh water plantain, and in addition there are millions of chubs or shiners, and just as soon as you get the small fish over the preliminary stage of their existence, there is plenty for them to live upon. But in that seven years I have yet to hear of one salmon trout being caught. I have wondered a great many times why it is so.

Mr. FAIRBANK.—I think you have got to have the rock formation.

Mr. CLARK.—I think there is one point that they all overlook—something I have been working on two or three years, and perhaps other fish-culturists, and that is we are planting our brook trout, salmon trout, young salmon and all of that class of fish in new waters too young. They should be grown or partially grown before we plant them. Another point which goes to prove that you get results quicker is, that wherever you have a hatching house on a stream that trout will live in it at all, you will get that stream stocked ten times quicker than any that you plant with fry, because your partially grown fish are always

getting away. Now, to stock new waters which are not trout streams proper, I think the way is to put the fish in from four months to six months, up to a year old; then you have a good stout healthy fish that has got something to live upon until it can accustom itself to the new class of food.

Mr. TOMLIN.—I would like to ask Mr. Clark to come back to the subject which Mr. Fairbank started on—is it possible to stock waters which are not indigenous to salmon or trout, with trout or salmon, and make it a success?

Mr. CLARK.—Certainly it is possible, because it has been done.

Mr. MATHER.—In regard to this matter which Mr. Tomlin has just brought up, and the question which he asks Mr. Clark about stocking with fish which are not indigenous to the water, I will say that within the past few years this lake trout, whose natural habitat is the great lakes and the small lakes of New York, has been introduced into Virginia. Col. McDonald has had success with them at Wytheville, and all of us who know anything about the distribution of this fish, know that our lake or salmon trout, never existed in Virginia in a state of nature. I am now hatching for Professor Baird one hundred and fifty thousand of these lake trout, which he has requested me to keep on Long Island for four or five months, in accordance with Mr. Clark's theory, and then distribute according to his order in the fall, and he tells me that Col. McDonald says that these lake trout will bear warmer waters than any of our salmon. That is not my experience. I have always believed them to be the most delicate in regard to temperature of any of our fishes, and have believed they require colder water; at the same time I am trying it, I am anxious to see if they will live in our warm waters on Long Island. Col. McDonald has raised them in Virginia, where there is not much difference in temperature.

Mr. CLARK.—I have one hundred and fifty thousand that we are keeping for the United States Commission to-day, from the same lot that Mr. Mather speaks about. Mr. Mather's one hundred and fifty thousand came from Northville. That is the pur-

pose of the United States Fish Commission from now on. Now, one remark that Mr. Dunning just spoke to me about—he thought that if you keep them in the troughs too long they become too much domesticated. Now, there is the point—you want to keep them long enough until they grow so that you have a good healthy fish, I mean a fish of two or three months about. Keep them there as long as you see fit and put them in your pond and feed them. That is my idea of it, keep them until you get a good healthy fish. We have had at Northville probably twenty-five thousand trout from a year old and upward, and next week shall probably plant one half of these fish. Some of them are probably at least a foot long.

Mr. Fairbank.—I have no doubt that these fish, kept until they become a mature fish, say a year old, will live in Lake Geneva, because there is enough food for them there, minnows and young fish that they can eat; but I don't believe that if they spawn there that the young fry which they hatch would ever come to maturity, because I don't think there is any food in that lake for them. The object of my making these remarks is that gentlemen when selecting a lake to put trout in, should look to the matter of the food for the fry, the young fish, and look particularly to the rock formation, the stone formation about it. I think that is the secret of it, and if you put your young fish in, keeping them until they are six months or a year old, and then put them in a lake where there is no food for the fry, it will never amount to anything. These mature fish will grow, but there will never be a second generation.

Mr. Mather.—What Mr. Fairbank has said about planting fish in suitable waters is no doubt true, and what Mr. Clark says about raising these young fish is also true, but it has been my experience that a young lake trout would prefer to have the tail or fin of his brother, to anything you can offer him. These little devils eat each other up.

Dr. Hudson.—I would inquire if there are any more papers to be read? If there are not, of course the more discussion we have, the better.

The Secretary.—There is but one more paper, and if it is in order I will now read it.

WORK AT COLD SPRING HARBOR, N. Y.

BY FRED MATHER.

This station of the New York Fish Commission, of which I am the superintendent, is on the north shore of Long Island and is intended for both salt and fresh water fish. Some work is also done for the United States Fish Commission, and the expense of this is borne by the general Government; the fish hatched are mainly distributed within the State. These latter fish are salmon, land-locked salmon and lake trout. In some cases such as the whitefish and shad, the eggs are given by the United States, and distributed by the State, an arrangement of great value to the latter.

During the past season we have had 262,000 trout fry at the station. Of these there were 40,000 eggs taken at the station, 112,000 eggs bought by Mr. John D. Hewlett, of Cold Spring Harbor, from James Annin, Jr., and W. L. Gilbert, the fry from which went into the waters of the north and south sides of Long Island, and 110,000 fry were received from the New York hatchery at Caledonia, in charge of Mr. M. A. Green. We have on hand at present writing 3,000,000 eggs of the smelt, 1,000 eggs of the *Oquassa* trout from Sunapee lake, New Hampshire, a gift of Mr. Elliott B. Hodge, Commissioner of that State. One million whitefish from eggs sent from the Northville, Michigan station, of the U. S. Commission, under charge of Mr. F. N. Clark, by order of Prof. S. F. Baird, have been hatched and distributed to Great Pond, near Riverhead, Long Island, and to Lake Ronkonkoma, a large lake in the center of the island. Previous plantings have been made in these lakes, but we have been unable so far to learn the result of them. It is hoped, however, that this fish may find a suitable home in these waters.

On this subject the County Treasurer of Suffolk County writes me from Riverhead, under date of January 30, 1886, as follows:

Fred Mather, Esq.: DEAR SIR—I will be very glad to assist you in any way. I have two parties out trying to get a specimen of the whitefish for you, but have failed so far on account of the ice, but will give it a thorough trial when the ice is gone and report to you. I am having a net fixed now to try to catch one or more. There is a pond

one and a half miles long just above Riverhead, good running water, which I hired two men to clean out of all worthless fish, such as catfish, suckers and what we call "roach." They caught about two and a half tons of turtles, which we carted off and buried. I was in hopes to get some black bass to place in this pond, and would like some whitefish for it now. We have a good place for lake trout, and if you will send us some and let us know when they will arrive, I will take especial pains for their care. Perhaps the brown trout might do well here. (Signed) J. HENRY PERKINS.

In the salt-water department, we have hatched and turned out over two million tomcods, or as they are sometimes called on the coast, frost fish, a small relative of the cod which seldom exceeds a pound in weight but is quite an important little food fish in our harbors. In January we had some 2,000,000 codfish eggs of which a very fair percentage were developing, until a blizzard blew through our old delapitated shanties, which we use for hatching houses, and froze up the pipes and the eggs in the jars. We had watched the development of these eggs daily under the microscope with great interest, and felt sure of success until the cold snap put a stop to all further development.

Of the brown trout, which by the way I believe to be the gamest trout in America, we had some three thousand eggs from our own fish, and have received some 25,000 from Germany through the courtesy of our good friend, Herr von Behr, president of the German Fishery Association, with a promise of 50,000 more from Herr von dem Borne, the well-known fishculturist of Berneuchen.

From the United States Fish Commission we have 500,000 salmon hatched from eggs received from the hatching station at Orland, Me., under charge of Mr. C. G. Atkins. These will go into the headwaters of the Hudson, the Salmon river emptying into Lake Ontario, the Oswego river and some 50,000 will go by request of State Commissioner R. U. Sherman, to the waters of the Saranacs, whose outlet is into Lake Chaplain and down into the St. Lawrence. These fish are now ready for distribution. We have also about 34,000 land-locked salmon from the United States works at Grand Lake stream, Me., in charge of Mr. H. H. Buck, also sent at request of General Sherman

for the waters near the Adirondack hatchery, either in Saranacs or in Lake Brandon, formerly known as Little Clear pond, now set apart for the State hatchery, on whose outlet it is located. The hatching season has been exceptionally good, and the losses of eggs and fry have been down to the minimum. The work at the station was done by two men and myself, until in February we were reinforced by Mr. F. A. Walters, superintendent of the Adirondack hatchery, who in former years had been my foreman, but who by an accident to the dam at the hatchery under his charge was relieved from duty there for the present. Last fall some new ponds were made ; the only ones which were there when the State took possession, were drained and quantities of eels taken from them, which, do doubt, destroyed many fry in former years. A fence has been put around the place and the grounds greatly improved. A new hatchery is really needed, as the two buildings now used for this purpose are not only small but so decayed as to be ready to tumble down. The men have worked in these buildings with six inches of ice under their feet, and at times with water freezing within ten feet of a red hot stove, and while ice has occasionly formed to the depth of a quarter of an inch in the hatching troughs it has done no damage there. But the two-inch iron pipes which convey the salt water to the jars did freeze and the flow was stopped. The eggs of the cod being so light that they would not bear a strong current, consequently the flow had to be shut down to a very small quantity, and all froze, as did some small English soles also.

The station, with these advantages of fresh and salt water, could be made, with a proper expenditure of money, the most important one in the United States. Its flow of fresh water is not anything like as great as at some other stations, but the height from which this water is taken—some forty feet above the hatchery, renders it possible to use the water over many times—in fact, we do so now. The brick building on the hill, in which there are twelve troughs with a capacity for 30,000 salmon each, receives the water first ; it then flows into a little pool, where egg shells and dirt may settle, and is conveyed on the upper floor of the main hatchery, in which there are eleven

troughs, and it then passes into the ponds. Another spring supplies the lower floor of the hatchery, which has nine troughs and hatching tables, on which twenty-five McDonald jars can be placed, and either salt or fresh water turned into them.

The fresh-water supply is capable of running more troughs than we now use, but the floor surfaces of the buildings will not permit them. The salt water which is within three hundred yards at low tide, is pumped into a reservoir on the hill and led into the buildings through a two-inch iron pipe, so that practically the sea is above us. The density of the water is sufficient to hatch codfish and oysters, and many oysters were hatched here last season by order of Mr. E. G. Blackford, of the New York Fish Commission, who is in charge of the oyster investigations of the State, an account of which is given in another paper. We have successfully hatched shad in the spring water here, and may repeat the experiment this year. It is now three years since we began work here, and our last season's work will foot up to about six millions of fry of different species, hatched and distributed.

Cold Spring Harbor, N. Y., April 10, 1886.

The CHAIRMAN.—The treasurer's report has not yet been read, and perhaps that should be read now. If the gentlemen will listen the secretary will read the report of the treasurer.

After the reading, it was moved and seconded that the report of the treasurer be accepted and placed on file. Carried.

The CHAIRMAN.—Article IV. of the Constitution, which was adopted to-day, provides that the regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or in default of such action, by the executive committee. It will, therefore, devolve upon this meeting to determine the time and place of the next meeting of the Society. Will any gentleman present make a suggestion in regard to that matter?

Mr. TOMLIN.—Before this matter comes up there is one resolution here I would like to read and get an expression of opinion of the gentlemen present. Yesterday the preponderance of the evidence brought before us showed that it was better to propa-

gate fish than it was to police the great waters of the lakes. I should like to present this resolution for consideration:*

Resolved. That it is the sense of this meeting that the public good of the States bordering on the chain of upper lakes would be best served by the establishment of fish hatcheries for the propagation of the spawn of whitefish and lake trout, and we do pledge ourselves to urge on our Congressional representatives and Senators to obtain an appropriation from Congress at this session to be devoted to this purpose.

Mr. TOMLIN.—I will say this has been a matter of consideration in Duluth for some time. We have communicated with our representative there, and also with the Senators, and the matter is in their hands. Since I have been in the meeting here I have been making some inquiries as to the best method of procedure, and learn it can only be done by Congressional appropriation or grant. If it is the sense of the meeting, I would like to have the matter discussed, and would offer it as a resolution if it will be accepted.

The CHAIRMAN.—You have heard the resolution that has been read. What action will you take upon it?

Mr. MATHER.—I should rather think, Mr. President, that this was a matter more pertinent to the Commissioners of Fisheries of the States and to the gentlemen who are interested in the stocking of the great lakes really, than one that came within the scope of this organization, because it is a local matter, as much so as if the Society should move that the hatching of codfish be extended, or the stocking of the Mississippi or some other local stream be recommended. That is the view I take of the matter.

The CHAIRMAN.—It doesn't seem to me that there is any objection if the gentleman simply wishes to get the opinion of the members present, from the bordering States perhaps, but otherwise, as Mr. Mather has suggested, it would be just as proper to petition Congress to stock the Connecticut river with shad, it seems to me, as it would be in this matter. The matter belongs more particularly to the State Commissioners and the citizens,

* Mr. Tomlin was elected a member of the Society, but has failed to complete his membership.

the inhabitants of the various States in this immediate neighborhood and not for the Society, which is supposed to represent the whole United States. That is the idea that presents itself to the chair. It is open of course for discussion by the Society.

Mr. DUNNING.—I move that the resolution be laid aside until we get through with the business now under consideration.

The CHAIRMAN.—Will any gentleman make any suggestion as to the time and place of the next meeting, either in the form of a motion or remarks in regard to the matter?

Mr. MAY.—In order to bring the matter before the Society, I move that the next annual meeting of this Society be held in Washington, on the second Tuesday of May, 1887.

Mr. BARTLETT.—I move the next annual meeting of the Society be held at Quincy, Illinois, the "Gem City of the West," the speaker tendering the hospitalities of the city to the Society should they conclude to hold the meeting at that place.

Mr. Dunning suggested that the Society meet at Madison, Wisconsin, at the next annual convention.

Mr. FAIRBANK.—I second the motion of Mr. May. I want to say here that I feel absolutely mortified at the lack of interest that our people have taken in this meeting. The Commissioners in the Western States, where they have a Commission, have not come here as I expected they would, and as they ought to have done, and they don't deserve another meeting. We could have had more interest from the general public if the matter had been a little better understood, and I supposed it would be. I don't know exactly where the fault is, but we have relied on Dr. Rowe to disseminate the matter in the press, and have the general public understand the full scope and intention of the meeting, and awaken some outside interest in it, but I have been absent myself and have been very much engaged in other things, and I supposed the matter was being attended to. I think we ought to rest on the laurels we have won this time, and try a meeting at Washington, which is really headquarters.

Mr. MATHER.—Mr. President, I agree with what Mr. Fairbank

has said about the advantages of Washington. Washington is a central point; it is at the head of the National Government, as some of you may know, and there is a vast museum of fishculture to be seen there. All the apparatus which has ever been devised is in the National Museum, and there are many advantages to be gained by having the meeting there. We have had the most successful meetings we have ever had in Washington, and while these questions come up about the East or West, I don't think it is worth while entertaining them. The Society is a national one in its scope and in its aim, and I do not hesitate to avow myself for Washington.

Mr. May.—I will amend my motion, Mr. Chairman, by moving that the next annual meeting of the Society be held at Washington, on the 12th, 13th and 14th days of May, 1887. Which motion, being duly seconded, was carried.

Mr. Fairbank.—I want to say a word or two more about the history of the Illinois Fish Commission, which the modesty of my associate, Mr. Bartlett, has prevented him from saying anything about. He has done all the work, and it is a little different work from what any other commission or State has done, and it has been so successful that I feel it is important to say something about it here, and call your attention to it, especially to the Commissioners from the Western States. You, most of you, know the character of the water we have here, and in my talks with him in relation to planting and hatching fish, I said I didn't think he could do much of anything in that work, and Mr. Bartlett suggested that as there were millions of fish that were left every year along the Mississippi river by the receding water, the young fish in the spring going to the shallow water near the shores, and as the river went down they were left on the bottom in the pools and ponds there, millions and millions of them to die, the best work we could do would be to gather up those fish, sort them out and distribute them, and that is the work we have been on for the past few years. We have a boat and a gang of men that go along the shores of the river and gather up these fish; and we have all varieties, from the small-mouthed black bass to the buffalo, and we take them up there by the bushel and

sort them out, and have a tank car, and that car is filled up with the young fish and is run over all the railroads in the State, and wherever we cross a river we stop and dump in our fish, and we have distributed a great many hundred thousand of fish with very gratifying success, as we get from all portions of the State reports of the pickerel, bass and perch where they never were known before. This is a work that is easily and cheaply done, and considering the numbers of the fish we have distributed, it is much cheaper than any other work that is done in that line. It is so very effective that I feel like suggesting it to the members, particularly of the Western States here, believing it is really a much more effective and profitable way of spending money than by hatching and attempting to plant the fish where they are not indigenous.

Mr. CLARK.—I understand they are planted in streams where they were not before. Do you think you would have got the same result if you had planted little fry in those same streams?

Mr. FAIRBANK.—Oh no, I agree with you the larger the fish the better, still the character of the water of the small streams is similar to the Mississippi. Before the fish are sorted he picks out the best varieties, thinking that is the best way to plant them, and last season he has taken all kinds and thrown them in, so that the poorer varieties may make food for the others.

Mr. DUNNING.—There is a fish that is becoming quite common all over the country, from north to south and east to west, and I would like to have an expression of this meeting in regard to the fish being a profitable one for propagation. It is the carp, and we read what a great size it attains in a very few years, and how prolific it is.

Mr. BARTLETT.—I would simply say that in my opinion it solves the question of the cheapest food for the greatest number of people, for the least amount of money. This question can be solved in the propagation of carp. In the state of Illinois there are now 6,000 carp ponds, and a great many of them are producing fish to-day. Applications this year on file for carp number 2,500, in round numbers, and they are increasing every day.

Out of that whole number I have not heard of twenty-five that have denounced it as a failure. I have one carp in my possession now that I think is among the first received from the general Government, a male carp, which measures 36 inches long and weighs 22 pounds. A large proportion of the ponds in the United States are ordinary farm ponds.

The resolution of Mr. Tomlin being called up for re-consideration, the same was read by the Chairman. The resolution and movement was supported by remarks from Dr. Sweeny, and opposed by Secretary Mather and President Hudson. The question occurring on the adoption of the motion, it was carried by a vote of the members present, standing six in affirmative to two in the negative.

Mr. Bartlett.—I have a resolution I would like to offer:

Resolved. That the thanks of this Society be extended to Mr. Potter Palmer for his courtesies to the members of this Convention, and for the use of this room.

Carried unanimously.

Mr. May.—I do not think it will be out of place for the Society to tender thanks to the local committee here, Mr. Fairbank, Dr. Rowe, and Mr. Bartlett, for the exhibit of live fish, etc., made at the Exposition Building, for the benefit of the members in attendance upon this meeting, and I move that the thanks of the Society be tendered to them. The motion was seconded and carried unanimously.

Dr. Sweeny.—While we feel grateful in our return of thanks, if it has not already been done, I move that the thanks of the Society be tendered to the gentleman who invited us to look at his oranges, bananas, etc. The motion receiving a second, was carried.

Mr. Bartlett.—I would move the thanks of this Society be tendered to the reporters of the papers for their courtesies and kindness to us during the sessions.

Carried unanimously.

On motion, duly seconded, the Convention here adjourned *sine die.*

TREASURER'S REPORT.

DR. EUGENE G. BLACKFORD, Treas., in Acct. with AMERICAN FISHERIES SOCIETY. CR.

1886.		1885.	
April 9. By amount of annual dues collected since May 1, 1885, - - -	$342 00	May 30. To W. V. Cox, expenses of annual meeting in Washington, - -	$20 60
		" To R. J. Geare, stenographer, -	26 00
		Dec. 11. To Postal-cards, - - - - - -	3 59
		1886.	
		Jan. 14. To J. M. Davis, printing reports, -	143 75
		15. To Postage, mailing reports, - -	4 85
		Apr. 7. To J. M. Davis, printing receipts, - -	3 00
		" To balance due Treasurer at last annual meeting, - - -	102 58
			$304 37
		Balance in treasury, - -	37 63
	$342 00		$342 00

MEMBERS

OF THE

AMERICAN FISHERIES SOCIETY.

Honorary Members.

H. R. H., the Crown Prince of Germany.

Baird, Spencer F., U. S. Commissioner of Fish and Fisheries, Washington, D. C.

Behr, E. von, Schmoldow, Germany; President of the Deutschen Fischerei Verein.

Borne, Max von dem, Berneuchen, Germany.

Huxley, Prof. Thomas H., London; President of the Royal Society.

Jones, John D., 51 Wall Street, New York.

Corresponding Members.

Apostolides, Prof. Nicoly Chr., Athens, Greece.

Buch, Dr. S. A., Christiania, Norway; Government Inspector of Fisheries.

Birkbeck, Edward, Esq., M. P., London, England.

Benecke, Prof. B., Königsberg, Germany; Commissioner of Fisheries.

Brady, Thomas F., Esq., Dublin Castle, Dublin, Ireland; Inspector of Fisheries for Ireland.

Day, Dr. Francis, F. L. S., Kenilworth House, Cheltenham, England; late Inspector General of Fisheries for India.

Feddersen, Arthur, Viborg, Denmark.

Giglioli, Prof. H. H., Florence, Italy.

Hubrecht, Prof. A. A. W., Utrecht, Holland; Member of the Dutch Fisheries Commission, and Director of the Netherlands Zoological Station.

Juel, Capt. N., R. N., Bergen, Norway; President of the Society for the Development of Norwegian Fisheries.

Landmark, S., Bergen, Norway; Inspector of Norwegian Freshwater Fisheries.

Lauderdale, the Earl of, Stirling, Scotland.

Lundberg, Dr. Rudolf, Stockholm, Sweden; Inspector of Fisheries.

Marston, R. B., Esq., London, England; Editor of the *Fishing Gazette*.

Macleay, William, Sydney, N. S. W.; President of the Fisheries Commission of New South Wales.

Sars, Prof. G. O., Christiania, Norway; Government-Inspector of Fisheries.

Solsky, Baron N. de, St. Petersburg, Russia; Director of the Imperial Agricultural Museum.

Sola, Don Francisco, Garcia, Madrid, Spain; Secretary of the Spanish Fisheries Society.

Wattel, M. Raveret, Paris, France; Secretary of the Société d'Acclimatation.

Young, Archibald, Esq., Edinburgh, Scotland; H. M. Inspector of Salmon Fisheries.

Walpole, Hon. Spencer, Governor of the Isle of Man.

Deceased Members.

Chappel, George.
Garlick, Dr. Theodatus.
Lawrence, Alfred N.
McGovern, H. D.
Milner, Prof. James W.
Parker, W. R.
Redding, B. B.
Redding, George H.
Rice, Prof. H. J.
Smith, Greene.
Stuart, Robert L.
Shultz, Theodore.

Members.

Persons elected at last meeting and who did not pay their dues do not appear in this list.

Adams, Dr. S. C., Peoria, Illinois.
Agnew, John T., 284 Front Street, New York.
Anderson, A. A., Bloomsbury, N. J.
Annin, James, Jr., Caledonia, N. Y.
Atkins, Charles G., Bucksport, Maine.
Atwater, Prof. W. O., Middletown, Conn.
Bailey, W. E., U. S. Fish Commission.
Banks, Charles, 453 Fifth Avenue, New York.
Barrett, Charles, Grafton, Vermont.
Bartlett, S. P., Quincy, Illinois.
Bean, Dr. Tarleton H., National Museum, Washington, D. C.
Belmont, Perry, 19 Nassau Street, New York.
Benjamin, Pulaski, Fulton Market, New York.
Benkard, James, Union Club, New York.
Bickmore, Prof. A. S., American Museum, New York.
Bissell, J. H., Detroit, Michigan.
Blackford, E. G., Fulton Market, New York.
Booth, A., Chicago, Illinois.
Bottemane, C. J., Bergen-op-Zoom, Holland.
Brown, J. E., U. S. Fish Commission.
Brown, S. C., National Museum, Washington, D. C.
Bryan, Edward H., Smithsonian Institution.
Bryson, Col. M. A., 903 Sixth Avenue, New York.
Butler, W. A., Jr., Detroit, Mich.
Butler, Frank A., 291 Broadway, New York.
Butler, W. H., 291 Broadway, New York.
Carey, Dr. H. H., Atlanta, Ga.
Carman, G., Fulton Market, New York.
Cheney, A. Nelson, Glens Falls, N. Y.
Clapp, A. T., Sunbury, Pa.
Clark, Frank N., Northville, Mich.
Clark, A. Howard, National Museum, Washington, D. C.
Comstock, Oscar, Fulton Market, New York.
Conklin, William A., Central Park, New York.
Conselyea, Andrew, Springfield, Long Island, N. Y.
Cox, W. V., National Museum, Washington, D. C.
Crook, Abel, 99 Nassau Street, New York.
Crosby, Henry F., 18 Cliff Street, New York.
Develin, John E., 30 Nassau Street, New York.

Dewey, J. N., Toledo, Ohio.
Dieckerman, George H., New Hampton, N. H.
Donaldson, Hon. Thomas, Philadelphia, Pa.
Dunning, Philo, Madison, Wis.
Earll, R. E., National Museum, Washington, D. C.
Ellis, J. F., U. S. Fish Commission.
Endicott, Francis, 57 Beekman Street, New York.
Evarts, Charles B., Windsor, Vt.
Fairbank, N. K., Chicago, Ill.
Ferguson, T. B., U. S. Fish Commission.
Foord, John, *Brooklyn Union*, Brooklyn, N. Y.
French, Asa B., South Baintree, Mass.
Garrett, W. E., P. O. Box 3006, New York.
Gilbert, W. L., Plymouth, Mass.
Goode, G. Brown, National Museum, Washington, D. C.
Habershaw, Frederick, 113 Maiden Lane, New York.
Haley, Albert, Fulton Market, New York.
Haley, Caleb, Fulton Market, New York.
Hall, G. W., Union Club, New York.
Harris, Gwynn, Washington, D. C.
Harris, W. C., 252 Broadway, New York.
Hayes, A. A., Washington, D. C.
Henshall, Dr. J. A., Cynthiana, Kentucky.
Hessel, Rudolf, U. S. Fish Commission, Washington, D. C.
Hewlett, Charles, Hewletts, Long Island, N. Y.
Hicks John D., Roslyn, Long Island, N. Y.
Hinchman, C. C., Detroit, Michigan.
Holmes, Dr. E. S., Grand Rapids, Michigan.
Hudson, Dr. William M., Hartford, Conn.
Humphries, Dr. E. W., Salisbury, Md.
Hutchinson, E. S., Washington, D. C.
Isaacs, Montefiore, 42 Broad Street, New York.
Jessup, F. J., 88 Courtlandt Street, New York.
Johnston, S. M., Battery Wharf, Boston, Mass.
Kauffman, S. H., Washington, D. C.
Kelly, P., 346 Sixth Avenue, New York.
Kellogg, A. J., Detroit, Michigan.
Kingsbury, Dr. C. A., 1119 Walnut Street, Philadelphia, Pa.
Lamphear, George, Fulton Market, New York.
Lawrence, G. N., 45 East 21st Street, New York.
Lawrence, F. C., Union Club, New York.
Ledyard, L. W., Cazenovia, N. Y.

Lee, Thomas, U. S. Fish Commission.
Loring, John A., 5 Tremont Street, Boston.
Lowrey, J. A., Union Club, New York,
Lydecker, Major G. I., U. S. Engineers.
Lyman, Hon. Theodore, Brookline, Mass.
Mallory, Charles, foot Burling Slip, New York.
Mansfield, Lieut. H. B., U. S. Navy Coast and Geodatic Survey, Washington, D. C.
Mather, Fred , Cold Spring Harbor, N. Y.
May, W. L., Fremont, Nebraska.
McDonald, Col. M., U. S. Fish Commission, Washington.
McGown, Hon. H. P., 76 Nassau Street, New York.
Middleton, W., Fulton Market, New York.
Milbank, S. W., Union Club, New York.
Miller, S. B., Fulton Market, New York.
Miller, Ernest, Fulton Market, New York.
Moore, George H. H., U. S. Fish Commission.
Murphy, W. W. J., U. S. Fish Commission.
Nevin, James, Madison, Wis.
O'Connor, J. P., U. S. Fish Commission.
Page, George S., 49 Wall Street, New York.
Page, W. F., U. S. Fish Commission.
Parker, Dr. J. C., Grand Rapids, Mich.
Parker, Peter, Jr., U. S Fish Commission.
Pease, Charles, East Rockford, Cuyahoga County, Ohio.
Pietmyer, Lieut., U. S. N., commanding Steamer *Fish-Hawk*.
Pike, Hon. R. G., Middletown, Conn.
Post, W., Knickerbocker Club, New York.
Ray, Hon. Ossian, M. C., New Hampshire.
Redmond, R., 113 Franklin Street, New York.
Reinecke, Theodore, Box 1651, New York.
Reynal, J., 84 White Street, New York.
Ricardo, George, Hackensack, N. J.
Riley, Prof. C. V., Agricultural Dept., Washington, D. C.
Robeson, Hon. Geo. M., Camden, N. J.
Rogers, H. M., Fulton Market, New York.
Roosevelt, Hon. Robert B., 17 Nassau Street, New York.
Ryer, F. R., New York City.
Schaffer, George H., foot Perry Street, New York.
Schieffelin, W. H., 170 William Street, New York.
Schuyler, H. P., Troy, New York.
Sherman, Gen. R. U., New Hartford, Oneida Co., N. Y.

Simmons, Newton, U. S. Fish Commission.
Smiley, C. W., Smithsonian Institution, Washington, D. C.
Spofford, Henry W., Smithsonian Institution.
Steers, Henry, 10 East 38th Street, New York.
Stone, Livingston, Charlestown, N. H.
Stone, Summer R., 46 Exchange Place, New York.
Swan, B. L., Jr., 5 West 20th Street, New York.
Sweeny, Dr. R. O., St. Paul, Minn.
Thompson, H. H., P. O. Box 25, New York.
Townsend, Isaac, Union Club, New York.
Van Brunt, C., 121 Chambers Street, New York.
Ward, George E., 43 South Street, New York.
Weeks, Seth, Corry, Erie Co., Penn.
West, Benjamin, Fulton Street, New York.
Whitaker, Herschel, Detroit, Mich.
Whitney, Samuel, Katonah, New York.
Wilbur, E. R., 40 Fulton Street, New York.
Wilcox, Joseph, Media, Penn.
Wilcox, W. A., 176 Atlantic Avenue, Boston, Mass.
Willets, J. C., Skeaneatles, N. Y., or 1 Grace Court, Brooklyn.
Wilmot, Samuel, Newcastle, Ontario.
Wilson, J. P., U. S. Fish Commission.
Wood, Benjamin, 25 Park Row, New York.
Woodruff, G. D., Sherman, Conn.
Woods, Israel, Fulton Market, New York.
Worth, S. G., Raleigh, N. C.

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American Fisheries Society.

1887.

TRANSACTIONS

—OF THE—

American

FISHERIES SOCIETY

Sixteenth Annual Meeting.

HELD AT THE

National Museum, Washington, D. C.

May 31st, and June 1st, 1887.

New York.

1887.

OFFICERS FOR 1887-8.

PRESIDENT,	W. L. MAY, - -	*Fremont, Neb.*
VICE-PRESIDENT,	H. H. CARY, - -	*Atlanta, Ga.*
REC. SECRETAAY,	FRED MATHER,	*Cold Spring Harbor, N. Y.*
COR. SECRETARY,	W. A. BUTLER, JR. -	*Detroit, Mich.*
TREASURER,	E. G. BLACKFORD, -	*Brooklyn, N. Y.*

EXECUTIVE COMMITTEE.

CALVERT SPENSLEY, *Chairman*, -	*Mineral Point, Wis.*
J. H. BISSELL, - - - - -	*Detroit, Mich.*
DR. R. O. SWEENEY, - - -	*St. Paul, Minn.*
DR. W. M. HUDSON, - - - -	*Hartford, Conn.*
LIVINGSTON STONE, - - -	*Charlestown, N. H.*
COL. M. MCDONALD, - - - -	*Berryville, Va.*
FRANK N. CLARK, - - -	*Northville, Mich.*

CONSTITUTION.

ARTICLE I.—Name and Objects.

The name of this Society shall be "The American Fisheries Society." Its object shall be to promote the cause of fish-culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of the interests of fish-culture and the fisheries; and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II.—Members.

Any person shall, upon a two-thirds vote and the payment of three dollars, become a member of this Society. In case members do not pay their fees, which shall be three dollars per year, after the first year, and are delinquent for two years, they shall be notified by the Treasurer, and if the amount due is not paid within a month thereafter, they shall be, without further notice, dropped from the roll of membership. Any person can be made an honorary or a corresponding member upon a two-thirds vote of the members present at any regular meeting.

ARTICLE III.—Officers.

The officers of this Society shall be a President and a Vice-President, who shall be ineligible for election to the same office until a year after the expiration of their terms, a Corresponding Secretary, a Recording

Secretary, a Treasurer, and an Executive Committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum.

ARTICLE IV.—Meetings.

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or in default of such action, by the Executive Committee.

ARTICLE V.—Changing the Constitution.

The Constitution of the Society may be amended, altered or repealed, by a two-thirds vote of the members present at any regular meeting, provided, at least fifteen members are present at said meeting.

SIXTEENTH ANNUAL MEETING

—OF THE—

AMERICAN FISHERIES SOCIETY.

FIRST DAY.

The Sixteenth Annual Meeting of the Society was held in the lecture room of the National Museum, at Washington, D. C., on Tuesday, May 31st, and Wednesday, June 1st. In the absence of Dr. W. M. Hudson, President of the Society, Vice-President W. L. May called the meeting to order at 11 A. M. on Tuesday, and after a short address the meeting adjourned until 3 o'clock in the afternoon.

On assembling again the following new members were elected: M. B. Hill, Clayton, N. Y.; Calvert Spensley, Mineral Point, Wis.; Walter D. Marks, Paris, Mich. The following were elected corresponding members: K. Ito, Hokkaido, Cho, Sapporo, Japan, member of the Fisheries Department of Hokkaido, and President of the Fisheries Society; W. Oldham Chambers, Esq., Secretary National Fish-Culture Association, South Kensington, London.

Dr. H. H. Cary said he had recently been examining oysters on the coast of Georgia with a view to planting in Lake Worth, Fla. The lake is situated on the east coast in one of the southern counties, near Jupiter Inlet, and is twenty-three miles long. It was once a fresh water lake, separated from the ocean by a barrier of coquina formation; but the inlet has been cut for the transportation of boats of ten tons or more, and now the lake is partially salt. The temperature of the Gulf Stream is not far

from 79 degrees Fahrenheit, and the lake is about the same. The question now arises, is this temperature too high for the breeding of oysters? The average depth of the lake is eight feet, and the bottom of the south end is muddy; other parts have hard bottom.

Mr. Whittaker.—What is the temperature of the Indian River?

Dr. Cary.—I think it is lower. The Gulf Stream diverges almost northeast, and the inlet to the lake is ten miles south of Jupiter Inlet. I believe that Mr. Mather has had some experience in raising oysters, and perhaps he can give us some information on this point.

Mr. Mather.—My experience has not been extensive enough to say at what temperature the eggs of the oyster will decline to hatch or the young will die. In 1885 Prof. Henry J. Rice came to Cold Spring Harbor to make some experiments in the propagation of oysters, and I loaned him a large wooden tank, in which he placed some young oysters immediately after hatching. The tank was put on the south side of the hatchery, and was fed by a stream of salt water not larger than a lead pencil; it was exposed to the sun and the water attained a temperature of 90 degrees, and no result was obtained. The next year I continued the experiments in the same tank placed on the north side of the building, with a temperature never exceeding 80 degrees, fair results being attained. How much higher a temperature they would have stood, I have no means of knowing.

Dr. Cary.—I can place layers of shells on the bottom for catching the spawn, but there is a great deal of moving sand, and I would like to know if this would be injurious to the young oysters.

Mr. Earll.—No doubt moving sands would be injurious to the young oysters, because the shells to which they were attached would be buried and the young would be mothered.

Dr. Cary.—There are oysters in Indian River, but it has been

a question whether there would be food in Lake Worth, the kind that oysters feed upon.

Mr. Mather.—The oyster feeds mainly upon diatoms, and attains a size in proportion to the food it gets. Some of the best feeding grounds on Long Island are in the brackish waters of the bays.

Mr. Earll.—While I don't know the limit of temperature at which oysters will spawn, I will say that I have found adults in water 84 degrees, and at 80 they spawn readily, Chesapeake Bay being 80 deg. every summer. Chrisfield, near Pokomoke Sound, and Tangiers Sound, famous oyster places, are often 80 to 85 degrees, and oysters spawn there in June and July.

The Secretary then read a paper by Prof. W. O. Atwater, entitled "Chemical Changes Produced in Oysters in Floating and their Effect upon the Nutritive Value." The meeting then adjourned until the following day.

SECOND DAY.

The meeting was called to order at 11:30 A. M. A telegram from Treasurer Blackford, stating his inability to attend, was read. The committee, consisting of Messrs. Whittaker, Spensley, Cary, Nevin and Earll, appointed on the previous day to nominate officers, made the following report:

For President.—W. L. May, Nebraska.
For Vice-President.—H. H. Cary, Georgia.
For Recording Secretary.—Fred Mather, New York.
For Corresponding Secretary.—W. A. Butler, Jr., Michigan.
For Treasurer.—E. G. Blackford, New York.

Executive Committee.—Calvert Spensley, chairman, Wisconsin; J. H. Bissell, Michigan; Dr. R. O. Sweeney, Minnesota; Dr. W. M. Hudson, Connecticut; Livingston Stone, New Hamp-

shire; Col. McDonald, Virginia; Frank N. Clark, Michigan; and upon vote these officers were declared duly elected.

The following paper was then read:

WORK AT COLD SPRING HARBOR.

BY FRED MATHER.

The past season has been the most successful one we have had since operations were begun here in 1883. We have turned out more fish than ever before, the figures for 1886 footing up to over 6,000,000; while this year the figures are over 9,000,000. There was a decrease in the numbers of salmon hatched and planted; also in trout, but an increase in shad and Adirondack frostfish and other species.

Salmon.—We received 300,000 eggs from the United States station on the Penobscot River, which hatched in such excellent condition that our loss was only about 8,000, which is the best we have ever done; of these fish 50,000 were planted in the Housatonic River, near Kent, New Milford and Falls Village, Conn.; 50,000 were placed in the Salmon River, near Albion, Oswego County, N. Y., and the remainder were placed in the smaller trout streams on the Upper Hudson, near North Creek, Warren County, N. Y., the terminus of the Adirondack Railroad. Mr. J. W. Burdick, General Passenger Agent of the D. and H. Canal Co., at Albany, very kindly gave us free transportation for cans and men to Albany, and Mr. C. E. Durkee, Superintendent of the Adirondack Railroad, offered us the same facilities over his road. Very encouraging accounts of our plantings of salmon in the Hudson are continually coming in. Last year over fifty were taken by different persons, and this year we are hearing of captures every day. A letter from Judge Danaher, of Albany, says that some of the fish have gone above the dam at Troy, and it is to be hoped that fishways will be placed there this year, a bill for that purpose being now before the New York Legislature. One salmon of 28½ lbs. has been taken this spring,

just below the dam at Troy, the largest fish of which we have any record of being captured in the Hudson. It has been proved conclusively that the Hudson can be made a salmon river. A bill introduced into the Legislature by Mr. Collins, which provides that no person shall at any time catch salmon in the waters of the State of New York with any device, save that of angling with line or rod, held in the hand, and then only from March 1st to August 15th in each year, passed both Houses and is now in the hands of the Governor.

Landlocked Salmon.—From 40,000 eggs received from the United States station at Grand Lake Stream, it was decided to plant 25,000 in the tributaries of the Hudson River, and the majority of the fish were sent to Mr. A. N. Cheney, of Glens Falls, who placed them in Clendon Brook, a trout stream where the sea salmon have done well for several years, while the remainder of the fry were planted in Long Island waters.

Brook Trout.—We have received 90,000 eggs from the New York station at Caledonia, and from these and eggs which we took from our limited number of stock fish, we have distributed in waters in the State 148,986 fish and fry, and we may say that in all cases where the numbers are given there is no guess work about it. The eggs are counted in a measure, and the rest are measured in the same glass; then when they are placed in the hatching troughs an account is kept of the number of dead eggs and fry taken from each trough, so that we can tell exactly how many fish there should be remaining in each compartment.

Brown Trout.—We received several consignments of the brown trout, *Salmo fario*, the common brook trout of Europe, from the Deutchen Fishcherei Verein, and also from Herr Max von dem Borne, the well-known fishculturist of Berneuchen. These were on account of the United States Fish Commission, and some of the eggs were sent to Michigan, Pennsylvania, Virginia and Washington. We hatched and distributed 34,000.

Loch Leven Trout (*Salmo levenensis*).—The eggs of this famous Scotch trout were sent to us by James Gibson Maitland, Esq., proprietor of the Howietown Fishery at Sterling, Scotland; 24,000 fry were produced from the eggs.

RAINBOW TROUT.—From 10,000 eggs sent us from the New York station, Caledonia, we have 8,000 strong, healthy fry.

SAIBLING (*Salmo salvelinus*).—This handsome trout, which is a native of the cool lakes of Germany and Bavaria, and attains a large size, being one of the chars, is a very brilliant fish. I have seen a specimen of 5 lbs., a male in breeding dress, in October, which was a brilliant crimson up to and above the lateral line. The eggs of this fish were distributed by the order of the United States Fish Commissioner in several States, some going to Virginia, Michigan and Pennsylvania. We sent some fry to Mr. Cheney for Lake George, and have retained some for breeders.

WHITEFISH.—From 1,000,000 eggs received from the United States station at Northville, Mich., we have planted in Dutchess County, N. Y., and on Long Island, over 900,000 fry.

FROSTFISH (*Prosopium quadrilateralis*).—This fish, which is found in the Adirondacks, where in Chateaugay Lake it is called "Shad," while in Maine and perhaps other places it is variously known as frost-fish, shad-waiter, etc. We received some 250,000 eggs from the New York station at Lake Brandon, and planted 200,000 fry in Duchess County, N. Y.

GRAYLING.—From 10,000 eggs sent to Mr. Blackford from France, we first thought we could not save a fish, but we hatched and brought to the point of taking food 350 fry from these eggs. We placed these in a small pond of about 15 feet in diameter and 1½ feet deep, where there was a good flow of water, but we have never seen one of the fish since.

SUNAPEE TROUT.—From Mr. E. B. Hodge, of the New Hampshire Commission, we received 10,000 eggs of the large trout recently discovered there; it is of the Oquassa type, concerning which there has been considerable dispute as to its species. We hatched 3,000 fry which seemed strong and healthy, which we placed in a pond similarly described for the grayling, but we have never been able to see them since.

WHITE PERCH.—We obtained some eggs of these fish from St. John's Lake, near the hatchery, and we also took some by hand from the fish; in all about 10,000 eggs. The eggs are ad-

hesive, and when laid by the fish are scattered similar to those of the carp. The fry are the smallest of any that I have hatched, and it requires a second look to see them in a small glass aquarium. We tried to retain a few, but we were not successful, as they died shortly after the absorbing of the sac.

Smelts.—Out of over 4,000,000 eggs we hatched and planted 2,000,000, or about 50 per cent., which is as good as we have ever done. I have on two former occasions read papers on the hatching of the fish before your honorable body, and have nothing new to add. The little smelt carries a great many eggs for its size; from 30,000 to 60,000, or perhaps more, and from 100 ripe females of good size, probably 5,000,000 could be obtained.

Shad.—We received from the United States Commission at Washington, over 5,000,000 eggs taken on the Potomac River, packed there and sent to Cold Spring Harbor. From this lot we hatched 2,000,000 fry, the last lot of eggs being a total loss; perhaps, because they remained in New York a day and were placed in a refrigerator, for the shad egg will not bear the chilling changes necessary to preserve the eggs of salmon or trout. Of the fry obtained, 800,000 were placed in the Hudson River at Albany, and 1,200,000 in Long Island streams, shipments being made to the Nissequoge River, at Smithtown, on the north shore of Long Island, and to the Connetquoit River, emptying into the Great South Bay; the planting in the latter river was made at Bridge Hampton. The weather was very favorable for hatching, and we used only spring water for them, and at no time the temperature of the water fell below fifty-nine degrees.

Last winter was the third winter we hatched the little tomcod and we turned out 3,400,000 in the harbor. This little fish, although not in great demand in the markets, forms an important item in the food supply of the inhabitants of Long Island, especially on the north side, as the boys catch them by hundreds and sell them to people in the vicinity. Shorty after we began our hatching operations and paid some attention to this fish. Cold Spring, Huntington and Oyster Bay harbors have been literally swarming with little tomcods, which are all credited by the people here to our hatching operations. We made no attempt

to hatch codfish, because of the condition of our hatchery, in which we could not keep the salt water pipes from freezing; but if we get a new building, as we expect, we will no doubt be able to proceed with the hatching of the cod, as has been done at Wood's Holl. Last winter, when every salt water pipe froze, we had a portion of our tomcod eggs in jars, and as salt water was not available we tried fresh water; and after hatching them in fresh water, we kept a large number in fresh water until they were ready to take food. No doubt this little fish could be acclimatized in the Great Lakes, and if not valued for food, would be desirable as food for the other fishes; but on Long Island the tomcod is regarded as a very desirable fish, and they are taken from all sizes up to perhaps 1½ lbs., which is the largest I have ever seen. They resemble the common cod in having three dorsal and two anal fins.

The following table gives a summary of this year's work:

Penobscot salmon planted in Hudson River	192,000
Penobscot salmon planted in Salmon River	50,000
Penobscot salmon planted in Housatonic River	50,000
Landlocked salmon planted in Hudson River	25,000
Landlocked salmon planted in Hatchery Pond	12,000
Brook trout planted in State waters	148,986
Brown trout planted in State waters	34,000
Rainbow trout planted in State waters	8,000
Loch Leven trout planted in State waters	24,000
Saibling planted in State waters	5,000
Whitefish planted in State waters	985,000
Tomcod planted in Cold Spring Harbor	3,400,000
Smelt planted in Cold Spring Harbor	2,000,000
Shad planted in Hudson River and Long Island	2,000,000
Frostfish (Adirondack)	200,000
Grayling	350
Sunapee Lake, N. H., Oquassa trout	3,000
White Perch	10,000
	9,157,336

Cold Spring Harbor, N. Y.

Col. McDonald.—So far, I have found no satisfaction in handling glutinous eggs, and the only real success I have met with was with the eggs of the white perch. We had collected some adult fish for Mr. Mather to send to Germany, and they were put in a perforated can in the river to keep for a few days, and on taking it out we found the side of the can coated with eggs, and sent it to the central station, hardly expecting any results, as we were not certain that the eggs were impregnated. In three or four days a large proportion of the eggs hatched; we had given them no attention at all, but simply left them alone. The eggs were evenly distributed on the can, and not hung in masses; now, perhaps as good a thing to do with glutinous eggs is to let them alone. The eggs of the yellow perch are laid in rows and hung over twigs and are merely suspended, where the eggs hatch without being disturbed. The catfish also lays glutinous eggs, but they are not stuck together; when the female lays them she leaves the male to hover over them. Now, it may be, that in all our attempts to hatch glutinous eggs we have only tried the same methods which we used in handling eggs which are non-adhesive, and have departed too far from nature in this matter.

Mr. Mather.—You will notice in my report I mention the fact that all the white perch which we tried to keep and feed died.

Col. McDonald.—So did ours, and I would like to hear from Mr. Marks about the "jack-salmon," or pike-perch, and what success he has had in hatching the glutinous eggs of this fish.

Mr. Marks.—We have hatched them for the past two years, and always by separating the eggs, and never in any other way. Although it is a long and tedious process to break the adhesive character of the eggs, it is the only way we have ever succeeded. Mr. Nevin has a paper on the hatching of the fish, and I can only say that our method is the same as his. The eggs are taken in the rivers and transported to the hatchery on trays.

The Society then adjourned until 2 p. m.

At the opening of the afternoon session, the Secretary read the following paper:

HATCHING THE WALL-EYED PIKE.

BY JAMES NEVIN.

The eggs of the wall-eyed pike cause more trouble while undergoing the process of hatching, than those of any other of our better class of fish, owing to their great adhesiveness. If not attended to properly before being placed in the hatching jars, they will stick together in bunches and float off through the outlet from the jar; and should screens be used to prevent this, they will be blocked up and the eggs carried off with the overflow. In our Milwaukee hatchery we have been raising pike fry for the past three seasons, and after trying various plans to counteract this evil, I have found the following to answer most satisfactorily.

As soon as impregnated the eggs are placed in tubs or some such vessels, and kept in constant motion by gently stirring until they have become hard, usually about five hours after being taken from the fish. They are then placed on cotton flannel trays and shipped in boxes in the same manner as whitefish eggs. As soon as they are received at the hatchery they are put into tubs, each tub to be not more than three parts full of eggs; they are then gently stirred with the hand until thoroughly loosened or separated. Immediately alongside should be a screen about three inches deep, and with holes just large enough to allow the egg to pass through. This screen fits into a tub of clean water and the eggs are dipped into it, and by gently shaking the screen they all pass through. By this means we know that each egg is separated from those surrounding it. I then take some of the sediment from the bottoms of the supply tanks and mix thoroughly with the eggs. A certain amount of this sediment adheres to the eggs and prevents the "bunching" when placed in the jars. After carefully following this plan the eggs can be placed in the jars, and if given a sufficient current of water to keep them moving very gently, there will be no danger of their floating off; nor do they require continual watching for the first forty-eight hours, as in the old method.

They take from fifteen to thirty-five days to hatch, according to the temperature of the water; the colder the water the longer the time required. When the fry are seven or eight days old, the little fellows will begin eating one another, and hundreds of them can be seen swimming in the tanks, each with a fish in his mouth that seems as large as himself. A small percentage of loss can be put down to this cause. We usually ship 50,000 in a twelve-gallon can, and find it necessary to use ice to keep the temperature of the water sufficiently low for them to stand the journey.

If fifty per cent. of the eggs can be hatched it can be considered very fair success. My opinion is that the general average is lower, although one case that came under my notice very much exceeded this. In the instance I refer to, there were two small shipping boxes of eggs sent to a hatchery and fully 75 per cent. were dead before leaving the spawning grounds, and the man who took the eggs told me that the rest of them died when put in the jars, and there were no more pike eggs sent to that hatchery that season; yet, on reading the annual report for the same season's operations at that hatchery, I saw that ten millions of wall eyed pike fry had been distributed! Men claim that they can hatch 50, 75 and even 90 per cent. of the eggs of certain fish; but here is a case that calls for special attention — several hundred per cent. from dead eggs. Why each egg, even if dead, must have brought forth twins or triplets, at least. I think it would be a capital idea for all of us that are engaged in pike culture to get our eggs from that locality in the future, and we should work hard to get very stringent laws passed protecting the locality, so that such a very prolific and peculiar class of fish should not be killed or destroyed.

There is no doubt that such deception as this injuriously affects the science of fishculture. The people of the country on reading or hearing of certain waters being stocked with thousands or millions of fry, as the case may be, naturally look for some beneficial result in the near future; and when no such result shows itself, they are inclined to say that artificial propagation of fish is very much over-estimated, nor can we blame them.

During the season just passed we secured for our Milwaukee

hatchery about 30,000,000 wall-eyed pike eggs, estimating them at 120,000 to the quart measure, and though as fine a looking lot of eggs as one could wish to see, I do not expect to have more than 10,000,000 fry to distribute. These 10,000,000 will fill about one hundred of the applications we have on file, leaving nearly another hundred to be left over until next year.

The best breeding grounds in Wisconsin for this fish are Green Bay, and Fox River emptying into it. Last winter our Legislature passed a law preventing the killing, buying, selling or having in possession any wall-eyed pike from these waters weighing less than 1½ lbs. A similar law for protecting our whitefish in Lakes Michigan and Superior, and their bays, was passed, and I have no doubt that a very few years will prove the wisdom of these laws, as the fish will be enabled to reach an age and size that will make them useful as breeders, and valuable as commercial fish. The main trouble hitherto has been that our lake fish have been caught when weighing a pound, and even less; consequently they had no opportunity of being reproducers of their kind, and brought such a low price per pound that a fishermen could hardly make more than living expenses.

In conclusion, I will give a brief summary of the fry that have been turned out and the number of applications filled in 1887 up to the present time, by the Wisconsin Fish Commission:

	No. of applications filled.	No. of fry planted
Brook trout	212	2,930,000
Mountain trout	119	1,350,000
Mackinaw, or lake trout	...	500,000
Whitefish	...	31,500,000
Wall-eyed pike	67	8,000,000
Total	398	44,280,000

Madison, Wisconsin.

By request, Mr. K. Ito, President of the Fisheries Society of Northern Japan, spoke on the Fishing Industries of his country, and his remarks were taken down by Mr. J. C. O'Connor, Secretary to Col. McDonald, of the United States Fish Commission. They were as follows:

THE FISHERIES OF JAPAN.

BY K. ITO.

Gentlemen: My intention in being present at this meeting is simply to benefit myself by gathering the crumbs that fall from your table, and not to benefit you by any talk, as I am not prepared to make any remarks; but at the same time I am very much interested in this society. I have heard and read so much about it while in my own country that it gives me great pleasure to be able to be present at this meeting, my great interest in which has prompted me to make the bold attempt of addressing you in a tongue with which I am not familiar.

Fish constitutes the chief article of food in Japan, and the fishing industries are necessarily the most important pursuit of the Japanese. It gives employment to 1,654,178 men, and yields $35,000,000. The peculiar features of the country afford every kind of fishing, and a great many varieties of the marine animals and plants are collected and utilized. It is not possible, however, without some previous preparation, for me to enumerate them or to give any account of the methods used for catching and curing them. I will, therefore, limit my subject to the fisheries of Northern Japan, or Hokkaido, with which I am more familiar. Hokkaido, more familiarly known to you under the name of Yesso, is one of the islands constituting the Japanese Empire, and is situated between 40 deg. 21 min. and 45 deg. 30 min. north latitude. It covers an area of about 319,000 square miles. The fisheries industry is the oldest and most important of the island. I will give a brief description of some of the principal fisheries of the Hokkaido.

First in the order of importance are the spring herring fisheries. The spring herring (*Clupea harengus*) approaches the western coast of the island in tremendous groups in the spring and early summer, and fishing is carried on from the first part of April to the last of June. The implements used for the capture of this fish are of two kinds — the gill-net and the moored trap-net.

The fish caught are gutted, and the bones and head taken off and dried upon scaffoldings. They are then made into bundles and sent to the southern part of Japan for food, while the roes, which are left, are dried on the flake or pickled and used for food. The head bones and gills, left after making the boneless herring, are also dried and utilized as fertilizers. But since the introduction of traps, about thirty years ago, and also the introduction of the pocket attachment after that, the catch became so enormous that every fish caught could not be utilized in the old way, and so the guano and oil industries were inaugurated. This industry, has grown from year to year, and at present is the most important of the fisheries of the Hokkaido. At present the total amount of the dried scraps manufactured reaches the enormous quantity of ninety thousand tons.

Next in importance is the salmon fishery. Our salmon belongs to the same *genus* as the Pacific coast salmon. There are two principal species of salmon, namely, the spring salmon (*Oncorhynchus perryi*) and the fall salmon (*Oncorhynchus haberi*). The spring salmon ascend the waters for the purpose of spawning in the months of May and June, and the fall salmon in the late fall months. The fall run is the more numerous of the two but inferior in flavor.

The methods used in the capture of this fish are several, but the principal kinds of nets used are the drag-seines, traps and gill nets in the seas, while only the drag-seines are used in the rivers. Some of the chief salmon rivers in the island can still compare with any salmon rivers in this country. The most important river for salmon is Ishikari, emptying into Strogonof Bay, on the western coast. Curing in salt used to be the only way of preparing salmon for market, but about eight years ago the Government employed Mr. Treat, of Eastport, Me., to introduce the method of canning the fish, and the new industry is growing constantly, and some of the articles are now sent to France. About three years ago a gentleman commenced a smoking business there, and this we hope will soon become one of the principal industries in the salmon fisheries.

Now, I will make a few remarks on the cod fisheries. The cod are most abundant in the winter and early spring. The fish-

ing ground at present is limited more to the in-shore, being from five to twenty-five miles from the shore and in water of 100 or 200 fathoms deep. The gear used for capture is the trawl exclusively, the construction of which is on the same principle as the trawls used in the New England fisheries of this country. The vessel used in this work is very small. It is an open, flat bottomed boat, about 36 feet in length, and is furnished with a single mast and one large clumsy rectangular sail. The most common method of treating the cod is to take off the head and bones and dry them very hard, like the Norwegian stockfish. The second way is to split and thoroughly cure them with salt. Still, some of the fish of the early catch are just gutted, slightly cured and sent away for more immediate consumption.

Another important fishery is the iwashi (*Clupea melanosticta*), a kind of herring that comes into the open sandy beach of the eastern coast in the months of June and July. Their schools are not so large as those of the spring herring, and are sometimes mixed with "seven dots" (*Etrumeus micropus*) and also with the young of the spring herring. The principal contrivance for the capture of this species is the drag-seine. The fish are all made into scrap and oil.

Next, I will mention the trepang fisheries. Trepangs, or sea-cucumbers, occur in the sandy bottom of the sea all along the coast, and are gathered by the use of a dredge. The fish caught are gutted and boiled in a decoction of mugglewolts or artemesia, and are then spread on a sort of cleat with bamboo bottom, and dried for exportation to the Chinese market.

Another fish for the Chinese market and of great importance, is the awabi. The awabi is a gigantic gasteropod, which is known on the Pacific coast of this country as "abalone." It is speared from an open boat just like the dories used by the New England cod fishermen, in water from two to four and a half fathoms deep. The fishermen formerly used cod oil in order to look into the bottom of this deep water, but water glass is now almost universally used for this purpose. About five years ago some adventurous fisherman introduced the diving apparatus, but in consequence of its injurious effect upon the propagation of the shellfish it was finally prohibited by legislation The

fresh product of this fish is separated from the shell, cooked, slightly smoked and dried, and then sent to the Chinese market.

Next comes the squid. The squid, which has its run in the fall, lives in big schools and is caught with the jig. It is split open, pressed and dried, and sent over to China.

Another product of the sea I would like to mention is the kŏmbu. The kombu is a kind of algæ belonging to the species of *Laminaria*. They occur in great abundance all along the coast, but the best kind is obtained on the northeastern coast, where the cold current comes down from the north. They are taken from the rock upon which they grow by the use of the wooden hook; they are then dried on the sandy beach, made into bundles and exported to China.

Now, let me say a few words in reference to the fishermen on the island. They are divided into three classes: First, outfitters; second, fishery proprietors; and third, employees. Outfitters are those who furnish the fishing gears, or capital or food supply to the fishermen who cannot fit out for themselves; the fishery proprietors are those who own the fishing vessels, fish houses and all fishing gears, and the employees are those employed by the fishery proprietors for the prosecution of the fisheries. Some of the fishing is done on shares, like the cod fishery of this country, while others are part in shares and part in wages, and in some cases certain parts of the entire catch are given to the gang of employees, besides regular wages.

The fishermen of my country are a most open-hearted and frank set of people, and are sometimes superstitious. Among the fishery proprietors there are a great many well educated, intelligent and progressive men. They have formed associations there for the purpose of preventing the manufacture of inferior articles and to adjust any disputes arising between fishermen. They have a fishery society there under the name of Hokusui Kyokwai, for the promotion and improvement of the fisheries. They publish monthly reports and distribute among the fishermen important and useful information in regard to the fisheries. They also publish the translated account of valuable information from this country. I think it will be of some interest to you to know that a recent number of a publication which I have

received contains a translation of the paper read before the Fishery Convention in London, by one of your prominent members, Prof. Goode. This society holds fairs for competing in the kind of articles manufactured by the different fishermen.

Now, I will say a few words in regard to the measures adopted by the Government for the promotion of the fisheries on the island. Under this head there are only a few laws for the protection of salmon. The principal feature of the legislation protecting salmon is that no stationary apparatus is allowed in the river, and the only kind of net allowed is the drag-seine. The next feature is that all nets must be taken out of the water from sunset to sunrise, that is, every night they must cease fishing. The next prominent feature is that fishing of any kind is prohibited in the spawning tributaries; and during the spawning season the Government appoints fish wardens to protect the fisheries from the poachers. In addition to this legislation in regard to salmon, there is also a law, which I have already mentioned, against the use of diving apparatus for the capture of the awabis.

Next, let me refer to the measures adopted for encouraging the fishermen. The Government has a fund which is loaned to the fishermen when they meet a bad season, and when they cannot borrow the capital to furnish their outfit. The Government also exempts for a certain length of time from the fishery tax all those fishermen who open new fishing grounds or who make new fishing establishments wherever it is impossible to make them without the expenditure of large sums of money.

Lastly, let me just touch on the legislation for regulating the fisheries. Under this head I may mention the method which has been adopted by the Government to govern all fishing grounds. In every fishing locality the position of all traps and seines is located on a map, and this map is filed in the county offices for the reference of fishermen, so that when they have any quarrel in regard to the position of nets it can be settled very easily. Under this head comes the regulation for inspecting the manufacture of "kombu." The manufacture of "kombu" lately became inferior, and to check this evil the Government has made a regulation requiring that all kinds of kombu must be inspected

and branded before it is exported, just as the mackerel are branded in this country.

Now, before I finish my remarks, let me read a few statistics concerning the fisheries of the island, which I prepared some time ago for the United States Fish Commission Bulletin:

NUMBER OF PERSONS, BOATS, SEINES AND NETS ENGAGED IN THE FISHERIES OF HOKKAIDO IN 1884.

	Hakodate district.	Sapporo district.	Nemuro district.	Total.
Fisheries propriet'rs	3,218	3,324	1,338	7,880
Employed hands...	17,440	33,630	14,703	65,773
Boats	15,100	16,800	3,473	35,373
Seines	496	267	326	1,089
Trap-nets	935	1,828	335	3,098
Gill-nets	150,820	33,365	65	184,250
Miscellaneous nets..	6,406	40	65	6,511

VALUE OF THE PRINCIPAL FISHERY PRODUCTS OF HOKKAIDO IN 1884.

Fishery.	Hakodate district.	Sapporo district.	Nemuro district.	Total.
	Yens.*	Yens.	Yens.	Yens.
Herring	1,412,762	2,023,883	108,003	3,544,648
Fall salmon	31,389	221,993	281,874	535,856
Spring salmon	1,528	5,617	118,675	125,820
Cod	16,396	85,048	712	102,156
Iwashi	116,577	15,434	1,640	133,651
Trepang	5,661	23,210	14,623	43,494
Ear-shell	26,818	95,123	.....	121,941
Squid	35,250	2,817	.. ....	38,067
Kombu	49,993	189,811	164,440	404,244
Sea-otter	.....	.....	3,150	3,150
Oyster	.....	.....	13,413	13,413
Total	1,696,974	2,662,936	706,530	5,066,440

*One yen equals about 80 cents.

I will remark here, however, that the figures just given are rather smaller than the average, on account of the poor catch and low prices during the year; but I think they will give an idea of the amount of the fish caught on the island.

At the conclusion of Mr. Ito's remarks, a vote of thanks was accorded him for his very interesting statements of the fisheries of a country of which we know so little, but which has made such rapid strides in acquiring the knowledge possessed by what a few years ago was an outside world to it. It is interesting to note, how closely all foreign methods have been copied by these exceedingly intelligent people, as soon as their ports had been opened to the world.

Mr. Earll then made the following remarks upon the changes and conditions of fish-culture, and the duties of fish commissioners under the new conditions, which were also taken down by Mr. O'Connor.

STATE FISH COMMISSIONERS.

BY R. EDWARD EARLL.

Mr. President—I do not intend to occupy the time of the Society with a paper, but it has occurred to me that this would be an excellent opportunity to bring to the attention of its members a matter, the importance of which, has been growing upon me for some time, namely: the changed condition of the duties of Commissioners of Fisheries. During the past few years it has been the one great and sole aim of all the Commissioners to hatch out and plant in the waters of their respective States as many fish of the different kinds as it was possible for them to hatch and distribute, with the means placed at their disposal; but we find that the time is rapidly approaching when it will become necessary for the officials to present to their respective governments, or to the appropriation committees of said governments, a clear and concise statement of all that is being accomplished with the money appropriated for fish-cultural work.

There has thus far been very little effort on the part of most of the States, and until recently upon the part of the general government, to obtain definite and detailed information regarding the extent and value of the fisheries of the various localities. It is, in my judgment, especially important that each Commissioner

of Fisheries should make himself, as far as possible, thoroughly familiar with the details of the fisheries of his own State. I say the fisheries, I mean more especially the commercial fisheries—that he should give special attention to the kinds of apparatus that are being introduced into the waters, and to the effect of each particular kind of apparatus upon the abundance of fish. It is only by this means that he will be enabled to tell what the result of his labors in stocking the waters is proving to be; and, further, it is only by this means that he will be enabled to stand between the man who condemns all fishing for profit and the man who wants no restrictions placed upon the fisheries. We have at the present time two contending parties—on the one hand, the angler, who wants fishing only for sport, and wishes to prohibit the use of every form of implement for catching fish that will interfere with the enjoyment of his summer vacation; and on the other hand, a large class of men who derive their entire support from the catching of fish for market. Each class comes with its complaints to the legislative bodies of the country, and the one that makes the best impression upon the legislature is very apt to carry the day. We are thus coming to have a series of laws enacted, some of which are very unwise and ought never to appear upon the statute books.

It is only recently that the U. S. Fish Commission has undertaken to familiarize itself with the details of the fisheries. Through an arrangement with the Census Office in 1879, Professor Baird, as you all know, was allowed an opportunity of carrying out an elaborate scheme for the investigation of the commercial fisheries. The work was placed under the direction of Prof. Goode, and the results of that work are beginning to appear. Owing to the exhaustion of the appropriation of the Census Office, they were able to print only a small portion of the material that was given them, but all of the manuscripts were retained by them until recently, when they were returned to the U. S. Fish Commission. Professor Goode and his associates has given much time to the preparation of these reports, the first two volumes of which have already appeared, and a large amount of additional material is now in type and will soon be ready for distribution. At least half a dozen more volumes similiar in size to those al-

ready out will be published. These will describe in detail the fisheries of all the more important fishing towns, the history, methods and present extent of each of the special fisheries; the characteristics of the fishermen both at home and at sea, the character, extent and location of the principal fishing grounds, the apparatus of the fisheries, and in addition will give an exhaustive statistical review of the fishery industries of the country.

But these reports will picture the fisheries as they were in 1880, and if they are to be available for present use, they must be kept up to date. With the desire to keep abreast with any changes that might take place, Professor Baird has frequently, since that time, sent out committees for the investigation of special subjects. It has been my privilege to be on several of these committees of investigation, and I have found how comparatively easy it is for one, even though a stranger to the locality, to get control of the details of the fisheries of any village or stretch of coast. From my experience I have been convinced that it would be entirely practicable for the Commissioners of several States to familiarize themselves with the changes that are taking place within their own borders, and to collect from year to year full and complete statistics of the fish caught in the territory under their control, and to publish these for the information of the public in their annual reports.

I have been much pleased to see in the States of Michigan and Wisconsin a very commendable effort in this direction. I think the Commissioners of both of these States have so familiarized themselves with the details of the fisheries in their own waters and with the influence of each kind of apparatus of capture, that they will be better able to cope with the problem of legislation than the Commissioners of other States, and also to show more clearly the influence of their fish-cultural operations upon the yield of the commercial fisheries. Any one who has heard the conflicting statements of the fishermen when summoned to give evidence regarding proper legislation for the protection of the fisheries, cannot fail to appreciate the importance of a full knowledge of all important details. In the Great Lake fisheries the gill net and pound net fishermen are at sword points; one claiming that the other is using the most destructive apparatus

that could be devised, while the angling element, especially in the more eastern lakes, is opposed to both. There have been frequent attempts in various States to entirely prohibit the pound net fishing, and there have been equally strenuous efforts to prohibit the use of the gill net, and again laws have been framed forbidding the use of haul seines, while fishing with pound nets and gill nets was in no way restricted. Numerous attempts have also been made to control and protect the fisheries by regulating the size of the mesh, but the utter inability of legislation to protect the small fish by this means is shown very clearly by the remark made to me yesterday by one of the gentlemen present, who claimed that if it were possible to insist upon the use of a given size of mesh, the fishermen could still regulate the size of the fish taken quite as his pleasure, by simply pulling hard upon the upper cork line at one end of the net, and upon the lead line at the other end, so as to draw the meshes together, and thus prevent the very smallest fish from going through.

I bring this matter to your attention because I have come to feel the importance of a definite and positive knowledge in this contest, when parties interested and parties whose interests are not apparent are clamoring for legislation. I think the time has arrived when the Commissioners of the different States should stand between the contending elements and should settle definitely in the minds of the law makers, the questions which are up for consideration, and nothing, in my judgment, is more necessary to a proper understanding of these questions than a careful comparison of the yield of the fisheries of the various localities from year to year.

With a desire to obtain as reliable statistics as possible, the U. S. Fish Commission has recently, through the co-operation of the Treasury Department, established a series of reports in which I think you will all be interested. The Secretary of the Treasury has consented to require of the owner and master of each vessel engaged in the fisheries of the United States, regardless of the locality, a detailed statement regarding the size, the value and the rig of the vessel ; the number of men employed ; the kind of apparatus used ; the locality where fishing ; the quantities and values of the fish caught, and other questions of importance af-

fecting that particular vessel. We are receiving hundreds of these reports every month from all portions of the coast, including the Pacific coast, the Gulf of Mexico and the numerous fishing ports of the Atlantic ; and we are thus gathering a very large amount of information regarding the vessel fisheries, but the boat fisheries are still unprovided for, and if it were possible for the Commissioners of each of the States to arrange to get reliable estimates of the quantity of fish caught yearly within their own borders, the number of men that are dependent upon these fisheries, and the distribution of the catch, I think we would be able to show what legislation is needed, and consequently, which I consider more important, to show clearly the importance of fishculture in the commercial fisheries and the achievements that fishculture has already attained. I should be very glad if some of the Commissioners present would give us a statement of what has already been done in their waters and of the difficulties, if such exist, in carrying out the line proposed. It has been suggested this afternoon in conversation, that there would be considerable difficulty owing to the fact that many of the Commissioners have only limited appropriations placed at there disposal, while others receive nothing whatever for their services, these being gratuitous, but it occurred to me that by having intelligent correspondents in each of the leading centers, men in whom they had confidence, it would be possible to get together for the State reports, very valuable contributions to our information regarding the condition of the fisheries.

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I will simply add for the information of any one here who sees no way of sending out agents to inquire as to the extent and value of the fisheries, that there is a growing prejudice among the commercial fishermen in favor of the work of the various State Commissioners and of the U. S. Fish Commissioner, and that they are now quite willing to give to the different commissions reliable information in answer to questions that may be asked. As a proof of this I will state that a circular was sent to each of the 1,600 vessels employed in the food fisheries of New England, and answers have been received from 1,560 of them, leaving only about 40 vessels out of the 1,600 that failed to respond. In the

case of the fisheries of the Great Lakes, inquiry circulars were recently sent to every fisherman on each of the five lakes, and more than ninety per cent. of them have been returned, and whenever, during the past two or three years, there has been an effort to obtain information by correspondence, this effort has been met with hearty co-operation on the part of those engaged in the commercial fisheries ; so that even without the expenditure of any considerable amount of money, it will be possible for those who are familiar with the localities and with the more intelligent resident fishermen to obtain possession of information from which very satisfactory reports can be prepared.

Washington, D. C.

The meeting then adjourned until the following day.

THIRD DAY.

On assembling the Secretary read the following paper.

FISH PRESERVATION BY THE USE OF ACETIC, BORACIC, SALICYLIC, AND OTHER ACIDS AND COMPOUNDS.

BY A. HOWARD CLARK.

An important method of preventing decomposition of animal flesh, is the application of antiseptic salts in a powdered form to the surface of the substance or to impregnate it with a solution either by atmospheric or hydraulic pressure. Among the commonest and most effective anticeptics, exclusive of chloride of sodium (common salt) are acetic, as contained in vinegar, and boracic acid. The latter preservative is fast coming into favor in the preparation of fishery products, because of its very satis-

factory properties. As compounded with salt in the form of a powder or in solution with tartaric acid, boracic acid is found to effectually preserve either dry or pickled fish in good condition for a long time.

At the Fisheries Exhibition, at London, in 1883, some Pacific salmon were shown which had been packed in a solution of boracic acid and other ingredients for several weeks, and after their long land and water journey, they were removed from the solution and exposed to the atmosphere at the fish market for several days, still retaining most of their original flavor and freshness.

It is my purpose in this paper to enumerate some of the more important methods of preserving fish by chemical treatment. Only a few of the numerous compounds which have been brought to the notice of fish curers have come into commercial use, though it is probable that many of them would upon trial be found effectual and profitable.

At the Centennial Exposition, at Philadelphia in 1876, there were some exhibits of fresh oysters and clams preserved in chemical liquids, and which the juries on awards pronounced of good quality. Boracic acid was reported to preserve animal matter for several months without changing the texture as common salt does. Citric and acetic acids also proved good preservatives, and fish cured in these acids were, after a little soaking in fresh water, found free from all unpleasant flavor.

In Portugal, fish are kept fresh for a considerable time by removing the viscera and sprinkling the abdominal cavity with sugar, when they are hung up to allow the sugar to impregnate the flesh as much as possible.

I shall notice the several methods in the order of their commercial importance, beginning with acetic acid, which, next to common salt, is perhaps the principal antiseptic in use in this country.

Vinegar, Spices, etc.—Lobsters, oysters, oyster crabs, mussels, scallops and some other marine products are preserved in vinegar alone, and packed in glass jars, are common in the New York markets under the name of "pickled" products. Herring,

mackerel, and other fish are largely prepared with compounds of vinegar and spices and sold as Russian sardines, maranated fish, soused fish, and by other trade names. The preparation of Russian sardines from the common sea herring, was introduced in this country by some enterprising New York merchants during the Franco-Prussian war. The principal seat of operations was Eastport, Me., and the methods employed, as patented in 1875 by Messr. Sellman, Reessing and Wolff, have been as follows: The fish while alive are thrown into strong brine contained in suitable casks on board the fishing vessels. This part of the process is important, as it not only kills the fish but prevents them from spoiling while being cleaned and cured. After being kept in the brine for at least ten days they are beheaded, gutted, scaled, and thoroughly cleaned in clear cold water and placed in large willow baskets or in sieves to drain off the superfluous water. In five or six hours they are spread upon packing tables and assorted as to size, each size being packed by themselves.

The fish are preserved and at the same time flavored by being packed with the following ingredients, the quantities given being for 120 lbs. of fish ; Two gallons vinegar, 1½ lbs. allspice, 2oz. pepper, 4lbs. sliced onions, 2lbs. sliced horse radish, 1lb. bay leaves, ½lb. cloves, ⅝lb. ginger, ¾lb. coriander seed, ¾lb. Chili pepper, and 2¼oz. capers.

In packing the fish a small quantity of vinegar and a thin layer of the other ingredients are placed in the bottom of the vessel and a layer of fish, placed back upward, are put in and gently pressed down. Another small quantity of vinegar and a thin layer of the other ingredients are put in and another layer of fish, and so on until the vessel is full. The fish are ready for market and consumption in about four days in summer and three to four weeks in winter.

Method of Sousing.—Soused mackerel and other fish may be prepared as follows : The fish are cut into pieces about 2 in. long and cleaned. A souse is made of cider vinegar and cloves, nutmeg or other spices, with parsley, bay leaf and onions, and the fish are immersed in this souse for twelve hours, when they are put in a second souse, made the same as the first with the ad-

dition of capers, olive oil, Worcestershire sauce, and extract of anchovy and lemons. After remaining in the second souse for ten hours, they are heated in the souse for four to eight hours at about 140 deg. Farh. and are then packed with the souse in air-tight pots or jars.

2. *Acetic Acid and Corbonate of Soda.*—The fish to be preserved are put in barrels, or other packages, with a liquid composed of acetic acid and carbonate of soda, in sufficient quantities to make a slightly acid solution of acetate of soda, to which is added enough water to give the liquid a density of three to five degrees. A few grains of salt may be added to give an agreeable taste, and about five drops of nitrate of soda for each pound of the liquid to preserve the color of the substance. Prepared chalk may be used instead of carbonate of soda. The fish may be kept in this solution, or after being saturated with a denser liquid may be dried.

3. *Boracic Acid and Common Salt.*—In the United States, until within a very few years, little advantage has been taken in the fish trade of the effective preservative power of boracic acid in combination with common salt. In 1883, the writer found that at Gloucester, Mass., the headquarters in this country for the curing of dry salted fish, the use of boracic acid was just begun, and then only by a few curers. Since that date, however, "Preservaline" and other chemical powders having the above substances as their base have come into quite general use, particularly in the warmer months, when without this preservative it is often found impossible to keep dry fish in good condition for many weeks or even days. This powder checks the peculiar reddening so commonly seen on dry salted fish in summer.

The chemical powder used by the Norwegians in preserving fresh herring for export, is a mixture of boracic acid and salt, using about two pounds of salt to each pound of boracic acid. Herring are packed in barrels, in the ordinary method with alternate layers of fish and powder, and after the barrel is headed they are "pickled" with a weak solution of pure boracic acid. Fish preserved in this way will keep perfectly fresh and of their natural flavor for a week or even longer. The Norwegians have

already succeeded in profitably competing with Scotland in supplying the London market with fresh herring thus prepared. A more complete preservation of herring, so that they will keep in good order for a long time, is obtained by the Sahlstrom process and by the Roosen method by which a solution of boracic acid and salt is thoroughly impregnated into the flesh, under a pressure of 60 to 100lbs. to the square inch. Successful experiments have been made in Scotland in treating fresh salmon by the Roosen process. Three hundred pounds of fish were packed in a strong steel barrel, and with a pressure pump the solution was forced into the salmon until they were thoroughly impregnated. After three weeks subjection to this process the fish were cooked and found of excellent flavor. Strongly made wooden barrels may be substituted for steel barrels, or, after being treated under pressure, the fish may be repacked with the solution in common fish barrels.

4. *Eckhart's Method.*—By this process, devised by John Eckhart, of Munich, and patented in 1880-'82, fish are prepared in a preserving salt consisting of a mixture of 50 per cent. common salt, 47½ per cent. chemically pure boracic acid, 2 per cent. tartaric acid, and ½ per cent. salicylic acid. The fish are first stripped of skin and bones, and the flesh is mixed with the preservative in the proportion of 20 grams of the mixture to one kilogram of fish flesh. They are then packed in cases of parchment or other material and put into casks which are filled with a gelatine solution made in the proportion of 50 grams of gelatine, 20 grams of the preservative, and 1,000 grams of water. The casks are then headed and connected with a force pump and more of the solution is forced in until the contents are well saturated. The sacks or cases of fish are then removed from the cask, and may be strewn over with more of the salt in dry condition and packed for shipment, or they may be shiped in casks with the liquid.

5. *Boracic and Acetic Acids.*—By the Am Ende process, boracic acid either in a liquid or pulverous state, is compounded with acetic acid in the proportion of about one drop of acetic to every ounce of boracic acid, and the compound is applied in the usual manner. The acetic acid is said to prevent the formation of fungi,

while the boracic acid prevents putrefaction by hindering the formation of bacteria.

6. *Boracic Acid, Chloride of Potassium, etc.*—The process devised by Hugo Jannish, consists in subjecting fish to a compound prepared of chloride of potassium, nitrate of soda, and chemically-pure boracic acid, which ingredients are dissolved in water, then mixed under exposure of heat, thus forming an antiseptic salt composed of hyponitrate of potash, hypochlorate of soda, borate of soda, borate of potash, and free boracic acid. The compound is applied either as a salt or in a more or less strong solution according to the time for which the fish are to be preserved.

7. *Borax, Saltpetre, etc.*—By the Herzen preserving process, meat is soaked for 24 to 36 hours in a solution of three parts borax, two boracic acid, three saltpetre, and one salt, in one hundred parts of water, and then packed in some of the solution. Before use the meat must be soaked 24 hours in fresh water.

8. *Glycerine and Antiseptic Salts.*—Oysters, fish, meats, etc., may be preserved by the use of a mixture of glycerine with phosphate of soda, or other antiseptic salt in connection with aldehyde, formic ether or acid in a solution of carbonic acid, water, glycerine, etc., and the preserved substance is then covered with paraffine or stearine.

9. *Miscellaneous Compounds.*—Among the many other chemical compounds that have been experimented with, and some of which have been successfully used in the commercial preservation of fish, may be mentioned :

a. A solution of gelatine and bisulphite of lime forced under pressure.

b. Fish flesh ground into fine pieces, pressed, moistened with glycerine, and wrapped in tinfoil.

c. A solution of saltpetre and alum in proportion of 5 lbs. of saltpetre and 4 oz. of alum to 60 gallons of sea water.

d. A solution of thymol, thymic acid, or any of the thymate salts and water, alcohol or glycerine.

e. Acetate of lime solution in water at a density of six degrees by the ærometer, to which is added acetic acid of eight degrees,

so that the liquid will produce sensible acid reaction upon blue reaction paper.

f. Sulphite of soda and carbolic acid in solution in proportion of 5 gals. water, 2 lbs. selphite of soda and 2oz. carbolic acid.

g. Hydrocarbon substituted for the air, which occupies the space in and around the substance to be preserved and subjecting the same to a temperature of about 30 deg. Fahr., the gas entering by a hole at the top and the air escaping through a hole in the bottom of the package.

h. A solution of salicylic acid dissolved in water, with which the fish is impregnated under hydraulic pressure.

i. Salicylic acid dissolved in hot glycerine and mixed with hot water. Preserving cans are coated on the inside with the above solution, then the fish are hermetically sealed in the ordinary manner.

j. A brine of composition for preserving fish, meat, etc., consisting of a solution of starch, sugar or glucose and common salt.

k. Fish are packed in a dry powder of gypsum and carbon and then enveloped with plastic shell, composed of gypsum, carbon, silicate of soda and water.

l. Fish washed in lime water then rubbed with pepper, saltpetre and fine salt.

m. Fish packed in air-tight packages and subjected to vapor of chloroform.

n. Gaseous sulphide of carbon is forced into the fish.

o. A solution of equal parts of water and bisulplute of lime.

p. Fish are covered with a coating of gum and immersed in acetate of alumina then a solution of gelatine allowing the whole to dry on the surface.

q. Fish are immersed in a solution of gum, benzoin and alum.

Washington, D. C.

MR. MAY—The paper just read treats of preserving fish by means of acids and other compounds, but does not say what effect these preservatives have upon the human stomach. Is there any

member present who has eaten fish which had been kept by any of these processes ?

Mr. Mather—I once ate a trout which had been kept for some ten days without ice. It was given to me by Mr. Thomas J. Conroy, of New York, the dealer in fishing tackle, and had been preserved by a patent process or powder called Rex Magnus, not now on the market, and which probably may have been largely composed of boracic acid, and the fish was fairly eatable, a little dry but still better than no fish.

Mr. May—As our worthy secretary still lives, it is fair to presume that the use of these preparations does not bring on instant death, but what would be the result of eating a thousand such prepared fish ?

Mr. Mather—I cannot say. Prawns preserved in some acid come to New York from Charleston and other southern ports, and I see them at Blackford's daily. I have here the quarterly number of the *Journal of the National Fish Culture Association*, edited by J. W. Willis Bund, Esq., and published by the Fish-culture Association of England, in which there are two items referring to this matter, which I will read. The first one favors the use of acids and the second one condemns them.

There are two sides to all questions. The *British Medical Journal* writes thus as to herrings cured with boracic acid: "Large quantities of herring preserved with salt and boracic acid being at present imported from Norway, and sold in the London and Newcastle markets, attempts have been made to prevent their sale. The National Sea Fisheries Protection Association discussed the question at a recent conference at Fishmongers' Hall, but no decision as to such fish was arrived at. It may, therefore, be worth while to point out that boracic acid, being the essential ingredient of our many food preservatives—be it in the form of the acid, of boroglyceride, or of borax—has been used for years, especially to preserve milk in hot weather, and no evidence has ever been brought forward even to suggest injurious effects upon the health ; it may, therefore, be taken to be perfectly harmless. The Norwegian herrings preserved with salt and boracic acid are of exceptionally fine quality, are per-

fectly fresh when brought into the market, and are, of course, subject to the usual process of inspection by the market inspectors, whose power of rejection is almost absolute. If, nevertheless, an outcry is heard against this sale, it is difficult to resist the belief that it is dictated by the jealousy which is notoriously rife in Billingsgate circles.

"The introduction of cheap food from new sources, welcomed as it always is by the public, is invariably opposed by the trade who, after all, reap the chief advantage in the long run. One has but to recall the sneers of the meat venders at American and Australian meat to value the agitation against Norway herrings at its proper worth. Hitherto, happily, we have been spared the bitter discussions which have on the Continent led to legislation against certain food preservatives, such as salicylic acid, which we in England admit without hesitation. The question is mainly one of public economy: Shall good food be wasted for want of a preservative, even if certain objections may be urged against their use, or shall we put up with these objections and aim at cheapening food for the masses, provided, always, that nothing which could injuriously affect their health is allowed to be present? A sufficient guarantee is afforded by the vigilance of medical officers, public analysts and market inspectors against the abuse of antiseptics and food preservatives."

On the other hand, a fish trader writes to the *Fish Trade Gazette:* "Hundreds of barrels of herrings from Norway out of one cargo were condemned, and also, that there were about 1,500 barrels unsold lying in London at that time. France will not admit the Swedish and Norwegian herrings nor any other fish cured by the process named. Many shopkeepers soon find out to their cost that once their customers have tasted herrings cured with acid they don't ask for them a second time."

Mr. S. G. Worth explained a new method for outlets of fish-ponds which he illustrated by a diagram upon the blackboard, and of this no notes were taken as Mr. Worth promised to send them, but as the report goes to press, they have not arrived.

THE CHEMICAL CHANGES PRODUCED IN OYSTERS IN FLOATING, AND THEIR EFFECT UPON THE NUTRITIVE VALUE.

BY PROF. W. O. ATWATER.

It is a common practice of oyster dealers, instead of selling the oysters in the condition in which they are taken from the beds in salt water, to first place them for a time, forty-eight hours, more or less, in fresh or brackish water, in order, as the oyster-men say, to "fatten" them, the operation being called "floating" or "laying out." By this process the body of the oyster acquires such a plumpness and rotundity, and its bulk and weight are so increased as to materially increase its selling value.

The belief is common among oyster-men, that this "fattening" is due to an actual gain of flesh and fat, and that the nutritive value of the oyster is increased.

A moment's consideration of the chemistry and physiology of the subject will make it clear, not only that such an increase of tissue-substance in so short a time and with such scanty food-supply is out of the question, but that the increase of volume and weight of the bodies of the oysters is just what would be expected from the osmose or dialysis which would naturally take place between the contents of the bodies of the oysters as taken from salt water, and the fresh or brackish water in which they are floated.

If we fill a bladder with salt water and then put it into fresh water the salt water will gradually work its way out through the pores of the bladder and, at the same time, the fresher water will enter the bladder; and further, the fresh water will go in much more rapidly than the salt water goes out. The result will be that the amount of water in the bladder will be increased. It will swell by taking up more water than it loses, while, at the same time, it loses a portion of the salt.

It does this in obedience to a physical law, to which the term osmose and dialysis are applied. In accordance with this law,

if a membraneous sac holding salts in solution is immersed in a more dilute solution or impure water, the more concentrated solution will pass out and at the same time the water or more dilute solution will pass in and more rapidly. The escape of the concentrated and entrance of the dilute solution will be, in general the more rapid the greater the difference in concentration and the higher the temperature of the two solutions. After the osmose has proceeded for a time, the two solutions will become equally diluted. When this equilibrium between the two is reached the osmose will stop. If the sac which has become distended is elastic, it will, after osmose has ceased, tend to come back to its normal size, the extra quantity of solution which it has received, being driven out again.

We should expect these principles to apply to the oyster. Roughly speaking, the body of the animal may be regarded as a collection of membraneous sacs. It seems entirely reasonable to suppose, that the intercellular spaces and probably the cells of the body would be impregnated with the salts of the sea-water in which the animal lives, and this supposition is confirmed by the large quantity of mineral salts which the body is found by analysis to contain, and which amounts, in some cases, to over 14 per cent. of the water-free substance of the body.

It seems equally reasonable to assume that osmose would take place through both the outer coating of the body and the cell walls. In the salt water the solution of salts within the body may be assumed to be in equilibrium with the surrounding medium. When the animal is brought into fresh or brackish water *i.e.*, into a more dilute solution, the salts in the more concentrated solution within the body would tend to pass in and produce just such a distension as actually takes place in the floating. If this assumption is correct, we should expect that the osmose would be the more rapid the less the amount of salts in the surrounding water; that it would proceed more rapidly in warm and more slowly in cold water; that it would take place whether the body of the animal is left in the shell or is previously removed from it; that the quantity of salts would be greatly reduced in floating; and that if it were left in the water after the maximum distension had been reached, the imbibed

water would pass out again and the oyster would be reduced to its original size. Just such is actually the case. Oyster-men find that the oysters "fatten" much more quickly in fresh than in brackish water; warmth is so favorable to the process that it is said to be sometimes found profitable to warm artificially the water in which the oysters are floated; although oysters are generally floated in the shell, the same effect is very commonly obtained by adding fresh water to the oysters after they have been taken out of the shell, indeed, I am told that this is a by no means unusual practice of retail dealers; oysters lose much of their salty flavor in floating; and it is a common experience of oyster-men that if the "fattened" oysters are left too long on the floats they become "lean" again.

This exact agreement of theory and fact might seem to warrant the conclusion that the actual changes in the so called fattening of oysters in floating are essentially gain of water and loss of salts. The absolute proof however is to be sought in chemical analysis. In the course of an investigation conducted under the auspices of the United States Fish Commission, and which included examinations of a number of specimens of oysters and other shell-fish, I have improved the opportunity to test this matter by some analysis of oysters before and after floating. The results of the investigation are to be given in one of the publications of the Commission. From this the following statements are selected as perhaps not without interest to the Fisheries Association. It is not improper that I should add here, that a portion of the expenses of the investigation was borne by one of the prominent officers of the association, Mr. E. G. Blackford.

The account just mentioned of the experiments is preceded by some citations regarding the practice of floating oysters which I insert here, adding that I should be greatly obliged for any further information upon the subject.

The following very opposite statements* are by Prof. Persifor Frazer, Jr., who attributes the changes mentioned to dialytic action.

* Note on Dialysis in Oyster Culture in Proceedings of Philadelphia Academy of Sciences, 1875 p. 472.

"The oysters brought to our large markets on the Atlantic seaboard are generally first subjected to a process of "laying out," which consists in placing them for a short time in fresher water than that from which they have been taken.

"Persons who are fond of this animal as an article of food know how much the 'fresh' exceed the 'salts' in size and consistency. The 'Morris Coves' of this city, (Philadelphia) while very insipid, are the plumpest bivalves brought to market. On the other hand, the 'Absecoms' and 'Brigantines,' while of a better flavor (to those who prefer salt oysters), are invariably lean, compared to their transplanted rivals, as also are the 'Cape Mays,' though from some reason, not to the same extent.

"The most experienced oyster dealers inform me, that the time for allowing the salt oysters taken from the sea-coast to lie out, varies, but is seldom over two or three days. At the end of this time the maximum plumpness is attained, and beyond this, the oyster becomes lean again, besides having lost in flavor."

The subjoined statements by Prof. J. A. Ryder are interesting in this connection. They are taken from a letter to Prof. Baird, U. S. Commissioner of Fish and Fisheries on "Floats for the so-called fattening of oysters."*

"The simplest and most practical structures of the kind which I have seen are the storage and fattening floats used by Mr. Conger, of Franklin City, Md., and now in use by all the shippers and planters in the vicinity of Chincoteague Bay. I have been informed that similar structures, or rather structures serving similar purposes, are in use on the oyster-beds along the shore of Staten Island, New York.

"It is probably a fact that in all these contrivances they take advantage of the effect produced by fresher water upon oysters which have been taken from slightly salter water. The planters of Chincoteague call this 'plumping the oysters for market.' It does not mean that the oysters are augmented in volume by the addition of substantial matter, such as occurs during the actual appropriation of food, but only that the vascular spaces

* Bulletin of the U. S. Fish Commission, 1884, p. 302.

and vessels in the animals are filled with a larger relative amount of water due to endosmose. It is a dealer's trick to give his product a better appearance in the market, and as such I do not think deserves encouragement, but rather exposure.

"Mr. Conger has actually resorted to warming fresh water to 60 fahr. in winter by steam pipes running underneath the wooden inclosure surrounding the 'fattening' or 'plumping' float. One good 'drink,' as he expressed himself to me, renders the animals fit for sale and of better appearance.

"Conger's floats are simply a pair of windlasses supported by two pairs of piles driven into the bottom. Chains or ropes which wind upon the windlasses pass down to a pair of cross pieces, upon which the float rests, which has a perforated or strong slat bottom and a rim 18 inches to 2 feet high. These floats I should think are about 8 feet wide and 16 feet long, perhaps 20. These structures are usually built alongside the wharfs of the packing and shipping houses and are really a great convenience in conducting the work."

Elsewhere Prof. Ryder speaks of the floats thus:

"The diaphragm itself was constructed of boards perforated with auger holes, and lined on the inside with gunny-cloth or sacking; and the space between the perforated boards was filled with sharp, clean sand. The space between the boards was about 2 inches; through this the tide ebbed and flowed, giving a rise and fall of from 4 to 6 inches during the interval between successive tides."

Mr. F. T. Lane of New Haven, Conn., writes as follows about the method of floating practiced by himself, and as I understand, by other New Haven growers :

"We do not always leave them two days in the floats,—as a rule, only one day. We put them into brackish water and take them out at low water or in the last of the falling tide as then the water is the freshest and the oysters are at their best. As it is not convenient for us to put them into the floats and take them out the same day we do not want the water too fresh. On one occasion, wishing to know what the result would be of putting the oysters into water that was quite fresh I had one of my floats taken up the river half a mile further than where we commonly

use them and 100 bushels of oysters put into it at high water and taken out at low water. They were in the water from 6 to 7 hours and came out very nice, fully as good as those floated 24 hours in the brackish water. It was a warm day and the water was warm. Under these conditions they will drink very quickly. I have seen them open their shells in 10 minutes after they were put into the water."

For the following valuable information I am indebted to Mr. R. G. Pike, Chairman of the Board of Shell-fish Commissioners of Connecticut:

"Connecticut oysters, when brought from their beds in the salt waters of Long Island Sound, are seldom sent to market before they have been subjected to more or less manipulation. As soon as possible after being gathered, they are deposited in shallow tide rivers where the water is more or less brackish; and are left there from one to four days; the time varying according to the temperature of the season, the saltness of the oyster, and the freshening quality of the water. Generally two tides are sufficient for the two 'good drinks' which the oyster-men say they should always have.

"This 'floating,' as it is called, results in cleaning out, and freshening the oysters, and increasing their bulk; or, as many oyster-men confidently assert, 'fattening' them. If the weather is warm, they will take a 'drink' immediately, if not disturbed; but if the weather is cold they will wait sometimes ten or twelve hours before opening their valves. Good fat oysters generally yield five quarts of solid meat to the bushel; but after floating two tides or more, they will measure six quarts to the bushel. After they have been properly floated they are taken from the shell—and as soon as the liquor is all strained off, they are washed in cold fresh water—and are then packed for market. In warm weather they are put into the water with ice, and are also packed with ice for shipping. Water increases their bulk by absorbtion and by mixing with the liquor on the surface of the oysters. The salter the oyster the more water it absorbs. In twelve hours one gallon of oysters, with their juices strained out, will take in a pint of water; but when very salt and dry they have been known to absorb a pint in three hours.

"Water always thickens the natural juices that adhere to the surface of the oyster; and makes them slimy. If too much water is added the oyster loses its plumpness and firmness and becomes watery and flabby.

"Oysters that have been floated bear transportation in the shell much better than when shipped directly from their beds. Oysters, too, that are taken from their shells and packed in all their native juices spoil much sooner than when their juices are strained out and the meats are washed in fresh cold water.

"Long clams are not floated—but round clams are. But both, when shucked are washed in fresh water. This cleanses them of mud, sand and excess of salt; increases their bulk and improves their flavor. After washing they will keep much longer without risk of spoiling. If the salt is left in them, as they come from their native beds, their liquor will ferment and they will quickly spoil.

"The above facts are gathered from the most intelligent men in the shell-fish business in Connecticut,—men who have had many years experience in gathering oysters and clams and preparing them for home and foreign consumption. They are all agreed that by judicious floating in the shell, and by washing and soaking when out of the shell, the oyster and the clam increase in bulk and improve in quality and flavor. We will not presume to say that this increased bulk is anything more than a mechanical distension of the organs and the cellular tissues of the oyster by water; or that its improved flavor is not due simply to a loss of bitter sea salt dissolved out by the water. Many intelligent cultivators are confident that the increase in bulk is a growth of fat; while just as many, of equal intelligence, declare that it is mere 'bloat' or distention, akin to that of a dry sponge when plunged into the water. The exact nature of the change the chemist alone can determine."

The following experiments were made with oysters supplied by Mr. F. T. Lane, of New Haven, Conn., a communication from whom was just quoted, and for whose courteous aid as well in furnishing the specimens as in giving useful information, I take this occasion to express thanks.

The oysters had been brought from the James and Potoma

Rivers and "planted" in the beds in New Haven Harbor (Long Island Sound) in April, 1881, and were taken for analysis in the following November.

Two experiments were made. The plan of each experiment consisted in analysing two lots of oysters, of which both had been taken from the same bed at the same time, but one had been "floated" while the other had not. The first specimen was selected from a boat-load as they were taken from the salt water, and the second from the same lot after they had been floated in the usual way in brackish water for forty-eight hours. For each of the two experiments, Mr. Lane selected, from a boat-load of oysters as they were taken from the salt water, a number, about three dozen, which fairly represented the whole boat-load. The remainder were taken to the brackish water of a stream emptying into the bay and kept upon the floats for forty-eight hours, this being the usual practice in the floating of oysters in this region. At the end of that time, the oysters were taken from the floats and a number fairly representing the whole were selected as before. Two lots, one floated and the other not floated, were thus taken from each of two different beds. The four lots were brought to our laboratory for analysis.

The specimens as received at the laboratory were weighed. Thereupon, the shell-contents were taken out and the shells and shell-contents both weighed. The solid and liquid portions of the shell-contents, *i.e.*, the flesh or "solid" and "liquor" or liquids were weighed separately, and then analyzed. We thus had for each lot, the weights of flesh and liquids, which, together, made the weight of the total shell contents, and the weight of the shells, which with that of the shell-contents made the weight of the whole specimens. We also had, from the analysis, the percentages of water, nutritive ingredients, salts, &c., in the flesh and in the liquids. From these data the calculations were made of the changes which took place in floating. For the details, which are somewhat extended, I may refer to the publications mentioned above. It will suffice here to give only the main results.

The body of the animal may be regarded as made up of water and so-called water-free substance. The water-free substance

contains the nutritive ingredients or "nutrients." These may be divided into four classes: (1) Protein compounds, the so-called "fleshformers" which contain nitrogen; (2) fatty substances, classed as Fats; (3) Carbohydrates; (4) Mineral Salts.* These constituents of the flesh of oysters have been but little studied. It is customary to assume them to be similar to the corresponding compounds of other food-materials, but very probably the differences, if known, might prove to be important. The mineral matters especially which are very large in amount, appear to include considerable of the salts of sea-water. Of the nature of the ingredients of the liquids but little is known. They consist mainly of water and salts and the amounts of their ingredients which are here reckoned as protein, fats and carbohydrates are very small, so that whatever error there may be in classing them with the ordinary nutrients of food, it will not very seriously affect the estimates of nutritive values.

GERERAL RESULTS OF THE EXPERIMENTS.

During the sojourn in brackish water both the flesh (body) and the liquid portion of the shell-contents of the oysters suffered more or less alteration in composition. In order to show clearly what the principal changes as shown by the chemical analysis were, some statistics may perhaps be permissible here.

CHANGES IN THE COMPOSITION OF THE FLESH (BODY) OF THE OYSTERS IN FLOATING.

1. The changes in the constituents of the body were mainly

* The technical terms here used demand perhaps a word of explanation. The "water-free substance" is the dry matter which is left when the water has all been driven out. Over three-quarters of the whole weight of the flesh ("solids") of oysters is water, so that the water-free substance makes less than one-fourth of the whole weight. As the oysters are ordinarily sold, *i.e.* after being floated, the flesh averages about one-fifth water-free substance. Taking both the flesh ("meat") and liquids ("liquor") together, the oysters as commonly retailed in our markets are about seven-eighths water and one-eighth water-free substance. That is to say the actual nutritive material in oysters as we usually buy them makes on the average just about one-eighth of the whole weight. It is worth noting that this proportion of actual nutriment is very near the same as in milk. The protein includes the parts of the oyster that are similar to the lean of meats, white of egg, casein of milk, &c The quantities of protein and of fatty and oily substance in the flesh of oysters is smaller, while that of carbohydrates (substances allied to sugar and starch) is far larger that in ordinary meats.

such as would be caused by osmose, though there were indications of secretion of nitrogenous matters and, especially, of fats, which are not so easily explained by osmose. This I will speak of later.

2. The amounts of gain and loss of constituents which the bodies of the oysters experienced may be estimated either by comparing the percentages found by analysis before and after dialysis, or by comparing the absolute weight of a given quantity of flesh and the weights of each of its ingredients before, with the weights of the same flesh and of its ingredients after dialysis. For the estimate by the first method we have simply to compare the results of the analyses of the floated and the not-floated specimens. Taking the averages of the two experiments, it appears that :—

The percentages of	Before Dialysis		After Dialysis
Water rose from	77.9	to	82.4
Water-free substance fell from	22.1	"	17.6
Total flesh	100.0		100.0
Protein fell from	10.5	"	8.9
Fat fell from	2.5	"	1.9
Carbohydrates &c., fell from	6.9	"	5.2
Mineral salts fell from	2.2	"	1.6
Total water-free substance of flesh	22.1		17.6

There was, accordingly, a gain in the percentage of water and a loss of that in each of the ingredients of the water-free substance. This accords exactly with the supposition that during the floating the flesh gained water and lost salts and other ingredients.

It will be more to the point to note the absolute increase and decrease in amounts of flesh and its constituents—in other words, the actual gain or loss of each, in the floating. Estimates by this method have been made and explained in the detailed accounts referred to. They make it appear that 100 grams of the flesh as it came from the salt water was increased by floating, in one specimen, to 120.9, and in the other to 113.4 grams. This is equivalent to saying, that the two specimens of flesh gained

in the floating, respectively, 20·9 and 13.4 per cent., or, on the average, 17.3 per cent. of their original weight. By the same estimates the water-free substance in the 100 grams of flesh before the floating, weighed, on the averrge, 22.1 grams, while that of the same flesh after floating weighed only 20.6 grams making a loss of 1.5 grams or 6.6 per cent. of the 22.1 grams which the water-free substance weighed before dialysis. The main results of the two experiments thus computed, may be stated as follows:—

In the "floating" of 100 grams of flesh (body) of the oysters:

The Weight of	Before Dialysis.	After Dialysis.
Water rose from	77.9 grams	to 96.6 grams.
Water-free substance fell from	22.1 "	" 20.6 "
Whole flesh rose from	100.0 "	" 117.2 "
Protein was assumed to remain the same	10.5 "	" 10.5 "
Fat (ether extract) fell from	2.5 "	" 2.3 "
Carbohydrates &c., fell from	6.9 "	" 6.0 "
Mineral salts (ash) fell from	2.2 "	" 1.8 "
	22.1	20.6

Estimating the increase or decrease of weight of each constituent in per cent. of its weight before floating:—

	Per cent of original weight.
The water gained	23.9
The water-free substance lost	6.6
The whole flesh (body) gained	17.3
The protein was assumed to neither gain nor lose.	
The fat lost	8.8
The carbohydrates, &c., lost	12.5
The mineral salts lost	15.5

In brief, according to these computations, the flesh lost between one-sixth and one-seventh of its mineral salts, one-eighth of its carbohydrates, and one-twelfth of its fats, but gained enough water to make up this loss and to increase its whole weight, by an amount equal to from one-seventh to one-fifth of the original weight.

These estimates are based on the assumption that the amount

of protein in the flesh remained unchanged during the floating. It seems probable however that the flesh may have lost a small amount of nitrogenous material. If this was the case the actual gain of flesh and of water must have been less and the loss of fats, carbohydrates and mineral salts, greater than the estimates make them. But there appears to be every reason to believe that the error must be very small, and since it would affect all the ingredients in the same ratio, the main result, namely, that there was a large gain of water and a considerable loss not only of mineral salts, but of fats and carbohydrates as well, can not be questioned.

CHANGES IN THE COMPOSITION OF THE LIQUID PORTION. (LIQUOR).

3. The liquids might be expected to receive material from the flesh, and to yield material to the surrounding water. The materials coming from the flesh would be such as the latter parted with by either osmose or secretion. Those yielded to the water would either escape by diffusion or be washed away when the shells were open wide enough to allow. What share each of these agencies had in effecting the changes that actually occurred in the liquids, the experiments do not and, in the nature of the case, cannot, tell. Comparing the percentage composition of the liquids before and after floating, as shown by the averages of the analyses in the two experiments, it appears that :—

The percentages of	Before Dialysis.		After Dialysis.
Water rose from	94.9	to	95.5
Water-free substance fell from	5.1	"	4.5
Total	100.0	"	100.0
Protein rose from	1.9	"	2.1
Carbohydrates, &c., rose from	0.7	"	1.1
Mineral salts fell from	2.5	"	1.3

The increase in the percentage of water, and the decrease in that of mineral salts are very marked. The quantities of fats ("ether extract") are too small to be taken into account. The increase of nitrogen and that of carbohydrates, though absolutely

small, are nevertheless outside the limits of error of analysis, and must, like those of the salts, represent actual changes in the composition of the liquids.

The experiments give no reliable data for the determinations of the absolute increase and decrease of the liquids and their constituents, so that it is imposible to say with entire certainty whether there was or was not an actual gain of protein or fats or carbohydrates. It would seem extremely probable however that the liquids received and retained small quantities of these materials from the flesh (bodies) of the animals.

CHANGES IN THE COMPOSITION OF THE WHOLE SHELL-CONTENTS, FLESH AND LIQUIDS.

4. Comparing the average percentage composition of the total shell-contents before and after floating in the two experiments, it appears that:—

The percentages of	Before Dialysis.		After Dialysis.
Water rose from	85.2	to	87.1
Water-free substance fell from	14.8	"	12.9
Total	100.0		100.0
Protein (N. X. 6.25) fell from	6.8	"	6.5
Fats, (ether extract) fell from	1.4	"	1.2
Carbohydrates, &c., fell from	4.3	"	3.7
Mineral salts, (ash) fell from	2.3	"	1.5
Total water-free substance	14.8		12.9

After so much detail, I ought perhaps to simply summarise the results in a few words and close. But one or two matters call for brief notice.

If the changes in composition of the oysters in floating were due to osmose or dialysis alone, we should expect simply a gain of water and loss of salts (and perhaps of carbohydrates). But the flesh seems to have lost a little carbohydrates and fats and probably protein also, along with the salts, while it was absorbing water. A way in which this may have come about is suggested by my colleague, Prof. H. W. Conn, who calls attention to the fact that some mollusks, when irritated, produce an extremely

abundant secretion of mucous or "slime," so much, indeed, as to sometimes render a small quantity of water in which the animals may be confined, quite sensibly gelatinous. He suggests that the change to fresh water may, indeed, induce such a secretion of mucous and perhaps of carbohydrates and fats as well, which would account for the increase of these substances in the liquids. The observation of oyster dealers that water always thickens the natural juices that adhere to the surface of the oyster and makes it slimy," accords with Prof. Conn's statement.

If such secretion did take place, the flesh must probably have lost a little protein during the floating. The estimates of absolute gain and loss of weight of flesh and ingredients (see detailed accounts of the experiments) are based upon the assumption that the quantity of protein was unaltered in floating. If protein was given off, therefore, the estimates are wrong. But the quantity of protein secreted and the consequent error must be, at most, very slight. If there is an error its effect would be to make the quantities of nutrients after floating appear larger than they really were. In other words, if the error was corrected it would make the loss of nutritive material in floating greater than it appears to be in the figures above given. As explained in the detailed report above referred to, I have assumed that the changes due to the ordinary processes of metabolism would be too small to materially affect the results.

The experiments might have been so conducted as to decide this question. It would have been necessary to simply take a larger number in each lot before and after floating and be certain that the number, weight, and bulk were the same in the floated and not-floated lots of each experiment. For instance, we might, in each experiment, carefully select two lots of, say a bushel, each, as taken from the beds, have the number of oysters the same in each bushel as an additional assurance that the two lots were alike, float one bushel and weigh and analyze both. A few experiments of this sort made under different conditions of time, temperature, kind and age of oysters, &c., would give reliable and valuable data. Unfortunately the means at my disposal did not permit so thorough experiments. I am

persuaded, however, that the results of such series of trials, if they could be made,—and I wish they might be—would be very similar to those of the trials here reported.

It is very interesting to note that these processes which we have been considering in the body of oyster are apparently very similar to processes which go on in our own bodies, namely those by which our food, after it is digested, finds its way through the walls of the stomach and other parts of the alimentary canal into the blood, to be used for nourishment. Physiologists tell us that the passage of the digested materials through the walls of the canal is in part merely a physical action, due to osmose, but that it is in part merely dependent upon a special function of the organs. In like manner the changes in the composition of the oyster, if the above explanation be correct, are caused partly by osmose, and partly by special secretive action, the cell walls and outer coating of the body of the oyster corresponding to the walls of the alimentary canal in the human body.

CONCLUSIONS.

The main points presented in this paper may be very briefly summarized thus.

In the floating of oysters for the market a practice which is very general and is also used for other shell-fish, the animals are either taken direct from the beds in salt water and kept for a time in fresher (brackish) water before opening, or water is added to the shell-contents after they are taken out of the shell.

When this treated, the body of the animal takes up water and parts with some of its salts; and small quantities of the nutritive ingredients escape at the same time. The oysters thus become more plump and increase considerably in bulk and weight. But the quantity of nutritive material, so far from increasing, suffers a slight loss.

In the experiments here reported, the increase in bulk and weight amounted to from one-eigth to one-fifth of the original amounts. This proportion of increase is about the same as is said to occur in the ordinary practice of floating or "fattening" for the market. According to this, five quarts of oysters in their

natural condition would take up water enough in "floating" to increase their bulk to nearly or quite six quarts, but the six quarts of floated oysters would contain a trifle less of actual nutrients than the five quarts not floated.

The gain of water and loss of salts is evidently due to osmose. The more concentrated solution of salts in the body of the animal as taken from salt water, passes into the more dilute solution (fresher water) in which it is immersed, while a larger amount of the fresher water at the same time enters the body. But part of the exchange and especially that by which other materials, namely fat, carbohydrates, protein, &c., are given off in small quantities, is more probably due to a special secretory action. There is thus a very interesting parallelism between these processes of secretion and osmose (dialysis) in the oyster and those in the bodies of higher animals, including man, by which the digested food is carried through the walls of the alimentary canal into the blood.

The flavor of oysters is improved by the removal of the salts in floating and they are said to bear transporting and to keep better. When therefore the oyster-man takes "good fat oysters" which "yields five quarts of solid meat to the bushel" and floats them so that "they will yield six quarts to the bushel" and thus has an extra quart of the largest and highest priced oysters, to sell, he offers his customers no more nutritive material—indeed, a very little less—than he would have in the five quarts if he had not floated them. But many people prefer the flavor of the floated oysters and since they buy them more for the flavor than for the nutriment, doubtless very few customers would complain if they understood all the facts. And considering that the practice is very general and the prices are regulated by free competition, the watering of oysters by floating in the shell, perhaps, ought not to be called fraudulent. But rather than pronounce upon this and other questions suggested by the above considerations, I should prefer to leave them to the Association for discussion.

NORTH CAROLINA ENCOURAGEMENT TO SHELLFISH CULTURE.

BY S. G. WORTH (RECENT STATE COMMISSIONER).

MR. PRESIDENT—The subject to which I desire to direct the attention of the Association is the new oyster law of my native State, North Carolina. When, four years ago, I met Lieut. Francis Winslow urging before this body the adoption of a resolution declaring in favor of private ownership of oyster bottom, I became impressed with his views, and brought about, after months of ceaseless work, the passage of a resolution in the North Caroline Legislature of 1885, instructing the State Board of Agriculture to expend $2,000 on a survey of the oyster area, looking to the adoption of the principle of ownership in fee simple. Accordingly the work was done, and two years later, in the session of January-February, 1887, in consequence of the able report of Lieut. Winslow, an act was passed which puts on sale, at twenty-five cents an acre, nearly a million acres.

Owing to apprehensions of assemblymen, lest too big a step should be taken at once, the bottom within two miles of the shore was exempted from the general provisions of the act and left under jurisdiction of the several counties, but the main body of Pamlico Sound and much additional area was put on sale, except the well established natural beds. These, as public beds, were exempted and still remain the common property of the people. Under laws operative prior to the new act, no person could own more than ten acres in a county, and as a consequence the limited areas precluded the use of dredges and restrained healthy growth. Under the new act a person can own any amount up to a square mile. The new law is regarded by the press of North Carolina as an advanced movement, and as the law found its origin in a meeting of this body, I now gladly lay it before you entire, with all that may be good or bad in it, and invite friendly criticism from members practically experienced in such legislation, looking to modifications which may be suggested to the next General Assembly in the interest of the people at large.

The Board of Shellfish Commissioners is elected outside the membership of the State Board of Agriculture, and consists of three—W. J. Griffin, Elizabeth City, Pasquotank county; I. B. Watson, Hyde county, and W. T. Caho, Bayboro, Pamlico county. Lieut. Francis Winslow, schooner *Scoresby*, of the U. S. Navy, is conducting all details of a complete survey.

THE ACT.

An act to promote the cultivation of shellfish in the State [of North Carolina].

The General Assembly of North Carolina do enact:

SECTION 1. That the State shall exercise exclusive jurisdiction and control over all shellfisheries which are or may be located in the boundaries of the State, south of Roanoke and Croatan Sounds and north of Core Sound.

SEC. 2. In order to carry out the purposes of this act, the southern boundary line of Hyde county shall extend from the middle of Ocracoke Inlet to the Royal Shoal Lighthouse, thence across Pamlico Sound and with the middle line of Pamlico and Pungo rivers to the dividing line between the counties of Hyde and Beaufort, and the northern boundary line of Cartaret County shall extend from the middle of Ocracoke Inlet to the Royal Shoal Lighthouse, thence to the Brant Island Shoal Lighthouse, thence across Pamlico Sound to a point midway between Maw Point and Point of Marsh, and thence with the middle line of the Neuse River to the dividing line between the counties of Carteret, Craven or Pamlico, and that portion of Pamlico Sound and the Neuse and Pamlico rivers not within the boundaries of Dare, Hyde or Carteret counties, and not a part of any other county, shall be in the county of Pamlico, and for the purposes of this act and in the execution of the requirements thereof the shore line as now defined by the U. S. Coast and Geodetic Survey shall be accepted as correct.

SEC. 3. The State Board of Agriculture shall, at the next regular meeting following the passage of this act, elect three commissioners of shellfisheries, whose term of office shall be one year, and the said Board of Commissioners of Shellfisheries shall be maintained so long as may be necessary to carry out the special duties confided to them by the provisions of this act and no longer, and they shall employ

such engineers and clerks as may be necessary for the execution of the said duties, and fix their compensation.

SEC. 4. The Board of Shellfish Commissioners shall make or cause to be made a survey and map of the area hereinbefore described, whereon shall be shown the location and area of all the natural beds, and of all the grounds which may have been occupied under authority of previous acts for the growing, planting or cultivation of shellfish, and upon the completion of the said survey in and maps of each or any county, the Board of Commissioners of Shellfisheries shall determine the location, area, limits and designation of each and every public ground in the county, and such public grounds are to include the natural beds, together with such additional areas adjacant thereto as may be deemed by the Board of Commissioners as necessary to provide for the natural expansion of the said natural beds; and having decided upon the location, area, limits and designation of the said public grounds, the Board of Commissioners of Shellfisheries shall publish the same for the period of thirty days at the court house door, and in four other public places in the county wherein the said public grounds are located, and any person or persons objecting to the decision of the Board of Commissioners of Shellfisheries, as published, may file a written protest, stating the ground for his or their objections, within the said thirty days, with the clerk of the Superior Court of the county wherein the said publication is made; upon payment to the said clerk of the sum of twenty-five cents, and at the expiration of the said thirty days, the said clerk of the Superior Court shall forward all such written protests to the Board of Shellfish Commissioners, and in case such protests are so filed and forwarded, the said Commissioners, or a majority of them, shall upon fifteen days' notice in writing, mailed or personally delivered to all parties in interest, hear and pass upon such protests or objections in the county in which the said public grounds are located; and the said Board of Commissioners of Shellfisheries, having fully informed themselves of the facts in the case, shall make within twenty days from the conclusion of the hearing a decision, which shall be final, and shall be so considered until reversed on appeal to the Superior Court. And at all hearings authorized by this act said Commissioners may, by themselves or their clerk, supœna witnesses and administer oaths, as in court of law.

SEC. 5. The Board of Commissioners of Shellfisheries shall, upon making the said final decisions as to the location, limits, area and designation of the several public grounds in the county, publish the same in the county in which the said public grounds are located, and in two newspapers having a general circulation in the State, and shall

announce in the said publication that at the expiration of twenty days from the first day of publication, the territory within said county and embraced within the provisions of this act will be open for entry in manner and form as hereinafter provided, and any person or persons desiring to raise, plant, or cultivate shellfish upon any ground in the county which has not been designated as public ground by the Board of Shellfish Commissioners, may, at the expiration of the said period of twenty days, make an application in writing, in which shall be stated as nearly as may be, the area, limits and location of the ground desired to the entry-taker of the county in which the said area for which application is made is situated, for a franchise for the purpose of raising or cultivating shellfish in said grounds, and the said entry-taker, having received said application, shall proceed as with all other entries, as provided in Section 2,765 of the Code, as amended, except that the warrant to survey and locate the ground or grounds shall be delivered to the engineer appointed by the Board of Commissioners of Shellfisheries and not to the county surveyor, and the said engineer shall make such surveys in accordance with the provisions of Section 2,769 of the Code, except that it shall not be necessary to employ chain-bearers, nor to administer oaths to assistants, nor to make surveys according to the priority of the application or warrant.

SEC. 6. The Secretary of State, on receipt of the Auditor's certificate as provided in Section 2,778 of the Code, shall grant to the applicant a written instrument conveying a perpetual franchise for the purpose of raising and cultivating shellfish in and to the grounds for which application is made, and the said written instrument of conveyance shall be authenticated by the Governor, countersigned by the Secretary, and recorded in his office. The date of the application for the franchise and a description of the ground for which such franchise was granted shall be inserted in each instrument, and no grant shall issue except in accordance with a certificate from the engineer of the commissioners of shellfisheries, as to the area, limits and location of the grounds in which the said franchise is to be granted, and every person obtaining such grant or franchise, shall within three months from the receipt of the same, record the said written instrument in the office of the register of deeds for the county wherein the said grounds may lie, and shall define the boundaries of the said grounds by suitable stakes, buoys, ranges or monuments; but no franchise shall be given in or to any of the public grounds as determined by the Commissioners of Shellfisheries, and all franchises granted under this or previous acts shall be and remain in the grantee, his heirs and legal representatives, provided that the holder or holders shall make in

good faith, within five years from the day of obtaining said franchise, an actual effort to raise and cultivate shellfish on said grounds. And provided further that the area hereinbefore described, lying within two statute miles of the main land or any island, shall be entered or held only by residents of the State of North Carolina, and no grant shall be made to any one person of more than ten acres of said territory, and no person shall hold more than ten acres in any creek unless the same shall be acquired through devise, inheritance or marriage. And all that territory within the provisions of this act and lying more than two miles from the mainland or any island, shall be subject to entry by any person, but no person shall be permitted to enter in any one period for five years, more than six hundred and forty acres.

SEC. 7. Twenty-five cents per acre shall be paid to the State Treasurer for all franchises granted, and all moneys received for the granting of franchises, or for taxes laid on the said grounds or on property thereon, shall be set apart and kept separate for the purpose of defraying the expenses entailed by the provision of this act, and any moneys remaining after the payment of said expenses shall be paid into and credited to the school fund.

SEC. 8. The Secretary of State is hereby authorized and empowered to hire and take upon leases, not exceeding a term of ten years, in the name and behalf of the State, any such plot or plots of ground within the State as may be deemed necessary for the constructing, erecting, setting, maintaining and protecting of signals, beacons, bound-stones, posts or buoys to be used in designating, locating, surveying or mapping any shellfish grounds, and any person who shall willfully injure or remove any such beacon, bound-stone, post or buoy, or any part, appurtenance or enclosure thereof, or any buoy, stake, mark or range of any private or public shellfish ground, shall be guilty of a misdemeanor.

SEC. 9. All grounds taken up or held under this or previous acts shall be subject to taxation as real estate and shall be so considered in the settlement of the estates of deceased or insolvent persons.

SEC. 10. The Board of County Commissioners shall have entire control and jurisdiction over all public grounds lying within the boundaries of the counties, shall place and maintain suchs marks, and shall prescribe and publish at the court-house door and at four other public places in the county, such rules and regulations as may be necessary for the governance and control of the fisheries on such public grounds.

SEC. 11. Any person who shall willfully commit any trespass or in-

jury with any instrument or implement upon any ground designated under this act, upon which shellfish are being raised or cultivated, or shall remove, destroy or deface any mark or monument set up by the Board of County Commissioners, by virtue of Section 10 of this act, or who shall violate the rules and regulations prescribed by the said board of the governance and control of the fishery on the public grounds, or who shall work on any oyster ground at night shall be guilty of a misdemeanor. But nothing in the provision of this or any act shall be construed as autnorizing interference with the capture of migratory fishes or free navigation or the right to use on any private ground any method or implement for the taking, growing or cultivation of shellfish.

SEC. 12. Entry takers shall make return to the Secretary of State of all franchises granted under this act in the same manner as provided in Section 2,776 of the Code, and the provisions of Sections 2,777 and 2,778 of the Code are hereby extended so as to cover the grants or franchises in grounds for raising or cultivating shellfish as authorized by this act, and all applications, grants, warrants and assignments of franchises in or to oyster grounds, shall be in manner and form as approved by the Attorney General of the State.

SEC. 13. All grants of grounds under previous acts for the purpose of cultivating shellfish in the territory within the provisions of this act are hereby confirmed and made good in the grantees, their heirs and assigns, provided the holders of said grounds shall, within one year, file with the Secretary of State certified copies of their licenses and surveys, and that the said surveys be found correct by the engineer of the commissioners of shellfisheries, and in case such surveys are said to be incorrect, the grounds shall be resurveyed by said engineer as soon as practicable, and in designating lots any person who has made in good faith an actual effort to raise or cultivate shellfish on the area for which application is made, shall have the prior right to a grant or franchise in said grounds; but nothing contained in the act shall be construed to validate any entry heretofore made of a natural bed.

SEC 14. The Commissioners of Shellfisheries shall keep books of record, in which shall be recorded a full description of all grounds granted under the provisions of this act, and shall keep a map or maps upon which shall be shown the position and limits of all public and private grounds.

SEC. 15. Any person who shall steal or feloniously take, catch or capture, or carry away any shellfish from the bed or ground of another, shall be guilty of larceny and punished accordingly.

SEC. 16. All acts or parts of acts in conflict with the preceding sections are hereby repealed.

SEC. 17. This act shall take effect on and after the day after its ratification.

Ratified this, the 28th day of February, A. D., 1887.

SALMON IN THE HUDSON.

MR. MATHER said that most of the members were aware that he had been hatching and planting salmon in the Hudson on account of the U. S. Fish Commission; that these fish had reappeared on the third and fourth years after planting. The first deposit was made in the spring of 1882, and many had been taken last year, also some this season which had been recorded in the pages of *Forest and Stream* and other papers.

The following letter bearing upon this subject, had just been received from Hon. Franklin M. Danaher of Albany, a gentleman well known as taking great interest in the protection of game, and who is the counsellor for the Eastern New York Fish and Game Protective Association.

Judge Danaher writes as follows:

Mr. FRED. MATHER, *Cold Spring Harbor, N. Y.*

MY DEAR SIR: A friend of mine, now in my office, tells me that he saw three small salmon (the largest estimated at six pounds) taken in a net yesterday above the dam at Troy, and near the lock which does not exceed one hundred feet above the dam. They evidently had come in this lock which had just been emptied. The fish were returned to the water. The information is reliable and I thought it would please you to know it. If they were true salmon? What do you think of it? He knows of others taken last week just below the dam.

Yours, F. M. DANAHER.

MIGRATION OF LAKE SUPERIOR FISH.

BY W. D. TOMLIN.

The whitefish of Lake Superior waters is prized for its edible qualities, and the increasing scarceness is causing much concern among those whose tastes incline toward this really fine fish for table use; already the supply is being drawn largely from Canadian waters and from Lake Winipeg; year by year men engaged in fishing have seen their feeding grounds almost deserted and the numbers still deminishing, until at last to find a large whitefish in their nets is indeed a curiosity. The present season's fishing finds scarce any body of fish north of Ontonagan, Michigan.

The fishermen of Wisconsin and Minnesota are thus deprived of any chance of obtaining this fish, by the gradual desertion of the old spawning grounds. I have said gradual because the disappearance has been fluctuating; some years the catches were prolific, then growing scarcer.

In the memory of men living in Duluth to-day, whitefish could be seen in Sucker Bay, twenty years ago, so thickly crowding one another that the water seemed alive with them. A thousand barrels of whitefish could have been put up from this single spawning or feeding ground.

Captain Vose Palmer, an old fisherman who owns property on this Bay, states that twenty-five years ago, it was enough to send an enthusiast wild to see the immense quantities of fish come in on the swells until the waters were apparently a compact mass of fish.

Captain R. H. Palmer, a brother of Vose Palmer, who has fished Superior waters nearly thirty years, says that beginning at Sucker Bay or Stony Point, and following the north shore line eastward up to Thunder Bay, near the mouth of the many rivers and streams that come tumbling into Lake Superior, you could find the feeding grounds of the whitefish, and in the bays near to them millions of young whitefish could be seen in their season.

Captain Alex. McDougall, a lake captain, whose earlier years

were spent in fishing, has cruised in almost every bay, creek, river or stream in this end of Lake Superior, and has carefully noted the habits of the whitefish, and knew both their spawning grounds, and feeding grounds, and has seen the young fry of whitefish by the million along the shores both of Minnesota and Wisconsin. Captain McDougall has endeavored for years to call attention to the alarming decrease of whitefish and to find some remedy for the same.

With the demand for whitefish, and the opening up of towns in the great Northwest, larger areas of nets were spread, more men were employed in the business, steam tugs were employed to carry the fish to the trains that delivered the fish to the towns on the prairies of the West and beyond the Mississippi; then came the first notice of any spasmodic migration or variation of the schools of fish on their feeding grounds. It became so noticeable as the years rolled by that the most observant and intelligent fishermen counted the years. There came an immense glut of fish, markets were overstocked, the nets in the water were filled, and before the men could dispose of the first catch and get to their nets, the fish were dead and thus useless. That season much fish was destroyed, not by any carelessness, but by such immense schools coming into the nets that the men could not take care of them.

The year following the season's catch was a diminution of the usual catch; the next season was still smaller; the fourth season was almost a failure; these singular periods vary, sometimes coming every fourth or fifth year, and until the men ceased expecting catches of whitefish they almost knew about the proportion of whitefish they might expect. These facts are confirmed by Captain Martyn Wheeler and Captain Ed. S. Smith, both engaged in fishing for some years, as well as fishermen of other nationalities who have been fishing these waters for more than twenty years.

The fishermen were at one time prodigal of the fishing wealth of this inland sea; it was each for himself, and undoubtedly grew careless both of the manner of netting and the disposing of offal when cleaning the fish for the market. When the facts began to present themselves in fierce array, "that there was a possibility

of over-fishing Lake Superior," then the fishermen began to enlarge the size of the mesh of their nets, and to discontinue the use of the pound nets; and using only seine nets for their work, the size of meshes was increased from 3½in. to 4in. Still finding their catches diminishing they inquired for causes; at this point the U. S. Fish Commission by some means had circulated along the chain of the Great Lakes the information that all offal dumped into the lake near to spawning grounds was injurious to spawn, and that both trout and whitefish would seek other grounds to spawn if fish offal was dumped into the lake.

One after another all the old grounds had been deserted until fishermen who went to Sucker Bay, twenty miles from Duluth, now have to go one hundred miles away, and then only get an occasional whitefish; while the fishing grounds proper lay in the body of the great lake, too far for fishermen at the eastern end of Lake Superior to reach them. It looked as if the fishermen had "killed the goose that laid the golden egg," not by any greed or gross carelessness, but by ignorance and inadvertence.

Many of them believe firmly that the coming of the schools of whitefish and lake trout are spasmodic, though they cannot assign causes for this. They think that after a season of unusual northeasterly gales succeeding spawning time the spawn is destroyed by a too violent agitation of the waters. And as Lake Superior eastern storms are often long continued and of destructive force, the next season's supply of young fry is very small in numbers. Another cause may be the careless dumping of fish offal on the feeding grounds, this causing the whitefish to seek new grounds until this substance is destroyed, and thus in three or four years the fish again return to the feeding grounds.

The fishermen of Lake Superior have learned that the whitefish is a very timid fish; that continued netting for two or three seasons will drive them to seek new grounds; and that once driven away it takes years for the schools to come to the same grounds again. The sentiment is increasing that the utmost care must be taken not to drive away the young fry that have been planted by the Minnesota Fish Commission, and are finding their way to feeding grounds that were fished ten years ago.

Duluth, Minn.

The subject of the time and place of the next annual meeting then came up for discussion. Mr. Spensley moved that the meeting be held in Detroit on the third Tuesday in May, 1888.

Dr. Cary moved to amend by substituting Washington for Detroit. A general discussion followed, in which the comparative merits of Washington, New York and other cities were discussed.

Mr. May thought that as Washington was the headquarters of the United States Fish Commission and the National Museum, where all articles and implements used in fish-culture could be seen, that it was the most interesting place in the country to hold the meeting; that there would be a better attendance, especially if Congress was in session, and that more valuable papers and discussions would come to the meeting there than at any other place.

Mr. Mather agreed with Mr. May, and said that as an original member, if not the founder of the Society, and speaking as one who had never missed a meeting since the first one in 1872, he could say that he had met with the Society at Albany, New York and Chicago; that it was his opinion that there were only two places that a good successful meeting could be held, — these were, as Mr. May has said, Washington, if Congress is in session at the time, and the second place was New York City; but as Michigan was strongly represented in the present meeting, and if in the judgment of the members the next meeting should be held at Detroit, he would pledge himself to attend it if possible, and do all in his power to make it a success.

Mr. Whittaker assured the members that he and his colleagues of the Michigan Fish Commission, would do everything in their power to make the meeting a success, and he felt assured that the Society would be well attended. The question was called on the amendment of Dr. Cary to meet in Washington, and was lost. The question on the original motion was then put and carried. It was resolved that the next meeting should be held in Detroit on the third Tuesday in May, 1888. Messrs. Whittaker, Mather and Bissell were appointed a committee to invite persons and papers for the next meeting.

A telegram from Treasurer Blackford was received, saying that he had been delayed by a press of business, but that his report had been forwarded by mail. On motion it was decided to accept his report, and the meeting adjourned.

The following is the report of the Treasurer for the last year.

TREASURER'S REPORT.

Dr. *American Fisheries Society in Account with Eugene G. Blackford, Treasurer.* **Cr.**

1886.			May 13th.	By Cash, F. Mather expenses at Chicago meeting, - - -	$2 20
	To Cash balance in Treasury, -	$37 63	"	By Cash, W. A. Butler, Jr. at Chicago meeting, - - -	13 54
April 29th.	To Cash amount received for Annual Dues to date, -	90 00	Sept. 27th.	By Cash, to bill of Stenographer at Chicago meeting, and express on report to N. Y. - -	50 50
			Oct. 23rd.	By Cash, Postage Stamps and Wrappers, - - - - -	5 43
			Dec. 31st.	By Cash, J. M. Davis, printing annual reports, - - - -	129 28
			1887.		
			May 6th.	By Cash, Postage Stamps and Wrappers, - - - - -	2 55
	Balance due Treasurer, - - -	$80 17	" 30th.	By Cash, F. Mather, Bill of Telegram, &c., - - - - -	4 30
		207 80			$207 80

MEMBERS

OF THE

AMERICAN FISHERIES SOCIETY.

Honorary Members.

H. R. H., the Crown Prince of Germany.
Behr, E. von, Schmoldow, Germany; President of the Deutschen Fischerei Verein.
Borne, Max von dem, Berneuchen, Germany.
Huxley, Prof. Thomas H., London; President of the Royal Society.
Jones, John D., 51 Wall Street, New York.

Corresponding Members.

Apostolides, Prof. Nicoly Chr., Athens, Greece.
Buch, Dr. S. A., Christiana, Norway; Government Inspector of Fisheries.
Birkbeck, Edward, Esq., M. P., London England.
Benecke, Prof. B., Königsberg, Germany; Commissioner of Fisheries.
Brady, Thomas F., Esq., Dublin Castle, Dublin, Ireland; Inspector of Fisheries for Ireland.
Chambers, Oldham, W. Esq., Secretary of the National Fish Culture Association, South Kensington, London.

Day, Dr. Francis, F. L. S., Kenilworth House, Cheltenham, England; late Inspector General of Fisheries for India.

Feddersen, Arthur, Viborg, Denmark.

Giglioli, Prof. H. H., Florence, Italy.

Hubrecht, Prof. A. A. W., Utrecht, Holland, Member of the Dutch Fisheries Commission, and Director of the Netherlands Zoological Station.

K. Ito, Esq., Hokkaido Cho., Sapporo, Japan, member of the Fisheries Department of Hokkaido, and President of the Fisheries Society of Northern Japan.

Juel, Capt. N., R. N., Bergen, Norway; President of the Society for the Development of Norwegian Fisheries.

Landmark, S., Bergen, Norway; Inspector of Norwegian Freshwater Fisheries.

Lauderdale, the Earl of, Stirling, Scotland.

Lundberg, Dr. Rudolf, Stockholm, Sweden; Inspector of Fisheries.

Marston, R. B., Esq., London, England; Editor of the *Fishing Gazette*.

Macleay, William, Sydney, N. S. W.; President of the Fisheries Commission of New South Wales.

Sars, Prof. G. O., Christiana, Norway; Government-Inspector of Fisheries.

Solsky, Baron N. de, St. Petersburg, Russia; Director of the Imperial Agricultural Museum.

Sola, Don Francisco, Garcia, Madrid, Spain; Secretary of the Spanish Fisheries Society.

Wattel, M. Raveret, Paris, France; Secretary of the Société d'Acclimation.

Young, Archibald, Esq., Edinburgh, Scotland; H. M. Inspector of Salmon Fisheries.

Walpole, Hon. Spencer, Governor of the Isle of Man.

Deceased Members.

Baird, Hon. Spencer F.
Carman, G.
Chappel, George.
Develin, John E.
Garlick, Dr. Theodatus.
Lawrence, Alfred N.
McGovern, H. D.
Parker, W. R.
Redding, B. B.
Redding, George H.
Rice, Prof. H. J.
Smith, Greene.
Shultz, Theodore.

Members.

Persons elected at last meeting and who did not pay their dues do not appear in this list.

Adams, Dr. S. C., Peoria, Illinois.
Agnew, John T., 284 Front Street, New York.
Anderson, A. A., Bloomsbury, N. J.
Annin, James, Jr., Caledonia, N. Y.
Atkins, Charles G., Bucksport, Maine.
Atwater, Prof. W. O., Middletown, Conn.

Bailey, W. E., U. S. Fish Commission.
Banks, Charles, 453 Fifth Avenue, New York.
Barrett, Charles, Grafton, Vermont.
Bartlett, S. P., Quincy, Illinois.
Bean, Dr. Tarleton H., National Museum, Washington, D. C.
Belmont, Perry, 19 Nassau Street, New York.
Benjamin, Pulaski, Fulton Market, New York.
Berkard, James, Union Club, New York.
Bickmore, Prof. A. S., American Museum, New York.
Bissell, J. H., Detroit, Michigan.
Blackford, E. G., Fulton Market, New York.
Booth, A., Chicago, Illinois.
Bottemane, C. J., Bergen-op-Zoom, Holland.
Brown, J. E., U. S. Fish Commission.
Brown, S. C., National Museum, Washington, D. C.
Bryan, Edward H., Smithsonian Institution.
Bryson, Col. M. A., 903 Sixth Avenne, New York.
Butler, W. A., Jr. Detroit, Michigan.
Butler, Frank A., 291 Broadway, New York.
Butler, W. H., 291 Broadway, New York.

Carey, Dr. H. H., Atlanta, Ga.
Cheney, A. Nelson, Glen Falls, N. Y.
Clapp, A. T., Sunbury, Pa.
Clark, Frank N., Northville, Mich.
Clark, A. Howard, National Museum, Washington, D. C.
Comstock, Oscar, Fulton Market, New York.
Conklin, William A., Central Park, New York.
Conselyea, Andrew, Springfield, Long Island, N. Y.
Cox, W. V., National Museum, Washington, D. C.
Crook, Abel, 99 Nassau Street, New York.
Crosby, Henry F., 18 Cliff Street, New York.

Dewey, J. N., Toledo, Ohio.

Dieckerman, George H., New Hampton, N. H.
Donaldson, Hon. Thomas, Philadelphia, Pa.
Dunning, Philo, Madison, Wis.

Earll, R. E., National Museum, Washington, D. C.
Ellis, J. F., U. S. Fish Commission.
Endicott, Francis, 57 Beekman Street, New York.
Evarts, Charles B., Windsor, Vt.

Fairbank, N. K., Chicago, Ill.
Ferguson, T. B., U. S. Fish Commission.
Foord, John, Brooklyn, N. Y.
French, Asa B., South Baintree, Mass.

Garrett, W. E., P. O. Box 3006, New York.
Gilbert, W. L., Plymouth, Mass.
Goode, G. Brown, National Museum, Washington, D. C.

Habershaw, Frederick, 113 Maiden Lane, New York.
Haley, Albert, Fulton Market, New York.
Haley, Caleb, Fulton Market, New York.
Hall, G. W., Union Club, New York.
Harris, Gwynn, Washington, D. C.
Harris, W. C., 252 Broadway, New York.
Hayes, A. A., Washington, D. C.
Henshall, Dr. J. A., Cynthiana, Kentucky.
Hessel, Rudolf, U. S. Fish Commission, Washington, D. C.
Hicks, John D., Roslyn, Long Island, N. Y.
Hill, M. B., Clayton, N. Y.
Hinchman, C. C., Detroit, Michigan.
Holmes, Dr. E. S., Grand Rapids, Michigan.
Hudson, Dr. William M., Hartford, Conn.
Humphries, Dr. E. W., Salisbury, Md.
Hutchinson, E. S., Washington, D. C.

Isaacs, Montefiore, 42 Broad Street, New York.

Jessup, F. J., 88 Cortlandt Street, New York.
Johnston, S. M., Battery Wharf, Boston, Mass.

Kauffman, S. H., Washington, D. C.
Kelly, P., 346 Sixth Avenue, New York.
Kellogg, A. J., Detroit, Michigan.
Kingsbury, Dr. C. A., 1119 Walnut Street, Philadelphia, Pa.

Lamphear, George, Fulton Market, New York.
Lawrence, G. N., 45 East 21st Street, New York.
Lawrence, F. C., Union Club, New York.
Ledyard, L. W., Cazenovia, New York.
Lee, Thomas, U. S. Fish Commission.
Loring, John A., 5 Tremont Street, Boston.
Lowrey, J. A., Union Club, New York.
Lydecker, Major G. I., U. S. Engineers.
Lyman, Hon. Theodore, Brookline, Mass.

Mallory, Charles, foot Burling Slip, New York.
Mansfield, Lieut. H. B., U. S. Navy, Washington, D. C.
Mather, Fred, Cold Spring Harbor, N. Y.
Marks, Walter D., Paris, Mich.
May, W. L., Fremont, Nebraska.
McDonald, Col. M., Fish Commissioner of the United States, Washington, D. C.
McGown, Hon. H. P., 76 Nassau Street, New York.
Middleton, W., Fulton Market, New York.
Milbank, S. W., Union Club, New York.
Miller, S. B., Fulton Market, New York.
Miller, Ernest, Fulton Market, New York.
Moore, George H. H., U. S. Fish Commission.
Murphy, W. W. J., U. S. Fish Commission.

Nevin, James, Madison, Wis.

O'Connor, J. P., U. S. Fish Commission.

Page, George S., 49 Wall Street, New York.
Page, W. F., U. S. Fish Commission.
Parker, Dr. J. C., Grand Rapids, Mich.
Parker, Peter, Jr., U. S. Fish Commission.
Pease, Charles, East Rockford, Cuyahoga County, Ohio.
Pietmyer, Lieut., U. S. Fish Commissioner, commanding Steamer *Fish-Hawk*.
Pike, Hon. R. G., Middletown, Conn.
Post, W., Knickerbocker Club, New York.

Ray, Hon. Ossian, M. C., New Hampshire.
Redmond, R., 113 Franklin Street, Eew York.
Reinecke, Theodore, Box 1651, New York.
Reynal, J., 84 White Street, New York.
Ricardo, George, Hackensack, N. J.

Riley, Prof. C. V., Agricultural Dept., Washington, D. C.
Robeson, Hon. Geo. M., Camden, N. J.
Rogers, H. M., Fulton Market, New York.
Roosevelt, Hon. Robert B., 17 Nassau Street, New York.
Ryer, F. R., New York City,

Schaffer, George H., foot Perry Street, New York.
Schieffelin, W. H., 170 William Street, New York.
Schuyler, H. P., Troy, New York.
Sherman, Gen. R. U., New Hartford, Oneida Co., N. Y.
Simmons, Newton, U. S. Fish Commission.
Smiley, C. W., Smithsonian Institution, Washington, D. C.
Spensley, Calvert, Mineral Point, Wis.
Spofford, Henry W., Smithsonian Institution.
Steers, Henry, 10 East 38th Street, New York.
Stone, Livingston, Charlestown, N. H.
Stone, Summer R., 46 Exchange Place, New York.
Swan, B. L., Jr., 5 West 20th Street, New York.
Sweeny, Dr. R. O. St. Paul, Minn.

Thompson, H. H., Bedford Bank, Brooklyn, N. Y.
Townsend, Isaac, Union Club, New York.

Van Brunt, C., 121 Chambers Street, New York.
Ward, George E., 43 South Street, New York.
Weeks, Seth, Corry, Erie Co., Penn.
West, Benjamin, Fulton Street, New York.
Whitaker, Herschel, Detroit, Mich,
Whitney, Samuel, Katonah, New York.
Wilbur, E. R., 39-40 Park Row, New York.
Wilcox, Joseph, Media, Penn.
Wilcox, W. A., 176 Atlantic Avenue, Boston, Mass.
Willets, J. C., Skeaneatles, N. Y., or 1 Grace Court, Brooklyn.
Wilmot, Samuel, Newcastle, Ontario.
Wilson, J. P., U. S. Fish Commission.
Wood, Benjamin, 25 Park Row, New York.
Woodruff, G. D., Sherman, Conn.
Woods, Israel, Fulton Market, New York.
Worth, S. G., Raleigh, N. C.

JOHN M. DAVIS, TYPOGRAPHER, 40 FULTON STREET, N. Y.

Brown Goode Coll.
National Museum,
Washington,
D.C.
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American Fisheries Society.

1888.

TRANSACTIONS

OF THE

✻ AMERICAN ✻

FISHERIES SOCIETY.

SEVENTEENTH ANNUAL MEETING.

HELD IN

ELK'S HALL, DETROIT, MICH.

MAY 15TH AND 16TH, 1888.

NEW YORK.

1888.

OFFICERS FOR 1888–9.

PRESIDENT,	JOHN H. BISSELL,	*Detroit, Mich.*
VICE-PRESIDENT,	S. G. WORTH,	*Washington, D. C.*
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FOR CONSTITUTION SEE PREVIOUS REPORT.

Seventeenth Annual Meeting

—OF THE—

American Fisheries Society.

FIRST DAY.

The Seventeenth Annual Meeting of the Society was held in the room of the Detroit Lodge of Elks, No. 34, in Detroit, Mich., on Tuesday and Wednesday, May 15 and 16. The attendance was larger than usual and many States were represented, the result of a special invitation of United States Fish Commissioner McDonald to the different State Commissioners to meet him and devise some system of co-operation between the States having common fishery interests, and also between them and the general Government. There was a meeting of the Commissioners in the evening.

The meeting was called to order Tuesday morning, May 15, President W. L. May, of Nebraska, in the chair. Dr. R. O. Sweeny, of Minnesota, made a happy opening address in which he alluded to the call of Col. McDonald for a conference of Commissioners and pointed out the great benefits that would come to all by uniting and working in concert. The following new members were elected: Messrs. Henry C. Ford, James V. Long, and W. H. Powell, of the Pennsylvania Fish Commission; M. E. O'Brien, Superintendent Nebraska Commis-

sion ; Richard Rathbun, of the U. S. Commission ; Hon. C. V. Osborn, James C. Hofer, John H. Law and A. C. Williams, of the Ohio Commission ; Hon. J. J. Stranahan, of Chagrin Falls, O. ; and Daniel H. Fitzhugh, of Bay City, Mich.

An invitation to visit the Lake St. Clair Fishing and Shooting Club was tendered by its president, Mr. W. C. Colburn, and accepted for Wednesday afternoon. The Society then adjourned until 2 P. M. and visited the white-fish hatchery of the Michigan Commission, in the city, where several millions of the eggs of the pike-perch were to be seen in the jars, and some trout and adult grayling were shown in aquaria, the whitefish season being passed.

On assembling in the afternoon the following paper was read :

THE DISTRIBUTION OF FRESH-WATER FISHES.

BY PROF. DAVID STARR JORDAN.

When I was a boy and went fishing in the brooks of western New York, I noticed that the different streams did not always have the same kinds of fishes in them. Two streams in particular in Wyoming County, not far from my father's farm, engaged in this respect my special attention. Their sources are not far apart, and they flow in opposite directions, on opposite sides of a low ridge—an old glacial moraine, something more than a mile across. The Oatka creek flows northward from this ridge, while the East Coy runs toward the southeast on the other side of it, both flowing ultimately into the same river, the Genesee.

It does not require a very careful observer to see that in these two streams the fishes are not quite the same. The streams themselves are similar enough. In each the waters are clear and fed by springs. Each flows over gravel and clay, through alluvial meadows, in many windings, and with elms and alders "in all its elbows." In both streams we were sure of finding trout (*Salvelinus fontinalis* Mitchill), and in one of them the trout are still abundant. In both we used to catch the

brook chub (*Semotilus atromaculatus* Mitchill), or, as we called it, the "horned dace"; and in both were large schools of shiners (*Notropis megalops* Rafinesque) and of suckers (*Catostomus teres* Mitchill). But in every deep hole, and especially in the mill-ponds along the East Coy creek, the horned pout (*Ameiurus melas* Rafinesque) swarmed on the mucky bottoms. In every eddy, or in the deep hole worn out at the root of the elm trees, could be seen the sunfish (*Lepomis gibbosus* Linnæus), strutting in green and scarlet, with spread fins keeping intruders away from its nest. But in the Oatka creek were found neither horned pout nor sunfish, nor have I ever heard that either has been taken there. Then besides these nobler fishes, worthy of a place on every school-boy's string, we knew by sight, if not by name, numerous smaller fishes, darters (*Etheostoma flabellare* Rafinesque) and minnows (*Rhinichthys atronasus* Mitchill), which crept about in the gravel on the bottom of the East Coy, but which we never recognized in the Oatka.

There must be a reason for differences like these, in the streams themselves or in the nature of the fishes. The sunfish and the horned pout are home-loving fishes to a greater extent than the others which I have mentioned; still, where no obstacles prevent, they are sure to move about. There must be, then, in the Oatka some sort of barrier, or strainer, which keeping these species back permits others more adventurous to pass; and a wider knowledge of the geography of the region showed that such is the case. Farther down in its course, the Oatka falls over a ledge of rock, forming a considerable water-fall at Rock Glen. Still lower down its waters disappear in the ground, sinking into some limestone cavern or gravel-bed, from which they reappear, after some six miles, in the large springs at Caledonia. Either of these barriers might well discourage a quiet-loving fish; while the trout and its active associates have sometime passed them, else we should not find them in the upper waters in which they alone form the fish-fauna. This problem is a simple one; a boy could work it out, and the obvious solution seems to be satisfactory.

Since those days I have been a fisherman in many waters—not an angler exactly, but one who fishes for fish, and to whose

net nothing large or small ever comes amiss; and wherever I go, I find cases like this.

We do not know all the fishes of America yet, nor all those well that we know by sight; still this knowledge will come with time and patience, and to procure it is a comparatively easy task. It is also easy to ascertain the more common inhabitants of any given stream. It is difficult, however, to obtain negative results which are really results. You cannot often say that a species does not live in a certain stream. You can only affirm that you have not yet found it there, and you can rarely fish in any stream so long that you can find nothing that you have not taken before. Still more difficult is it to gather the results of scattered observations into general statements regarding the distribution of fishes. The facts may be so few as to be misleading, or so numerous as to be confusing; and the few writers who have taken up this subject in detail have found both these difficulties to be serious. Whatever general propositions we may maintain must be stated with the modifying clause of "other things being equal"; and other things are never quite equal.

Still less satisfactory is our attempt to investigate the causes on which our partial generalizations depend—to attempt to break to pieces the "other things being equal" which baffle us in our search for general laws.

We now recognize about six hundred species of fishes as found in the fresh waters of North America, north of the Tropic of Cancer, these representing thirty-four of the natural families. As to their habits, we can divide these species rather roughly into the four categories proposed by Professor Cope, or, as we may call them—

(1) Lowland fishes; as the bow-fin, pirate perch, large-mouthed black bass, sunfishes and some catfishes.

(2) Channel fishes; as the channel catfish, the moon-eye, gar-pike, buffalo-fishes and drum.

(3) Upland fishes; as many of the darters, shiners and suckers, and the small-mouthed black bass.

(4) Mountain fishes; as the brook trout, and many of the darters and minnows.

To these we may add the more or less distinct classes of (5) Lake fishes, inhabiting only waters which are deep, clear and cold, as the various species of whitefish and the great lake trout; (6) Anadromous fishes, or those which run up from the sea to spawn in fresh waters, as the salmon, sturgeon, shad and striped bass; (7) Catadromous fishes, like the eel, which pass down to spawn in the sea; and (8) Brackish-water fishes, which thrive best in the debatable waters of the river-mouths, as most of the sticklebacks and the killifishes.

As regards the range of species, we have every possible gradation from those which seem to be confined to a single river, and are rare even in their restricted habitat, to those which are in a measure cosmopolitan,* ranging everywhere in suitable waters.

Still, again, we have all degrees of constancy and inconstancy in what we regard as the characters of a species. Those found only in a single river-basin are usually uniform enough; but the species having a wide range usually vary much in different localities. Continued explorations bring to light, from year to year, new species; but the number of new forms now discovered each year is usually less than the number of recognized species which are yearly proved to be intenable. Three complete lists of the fresh-water fishes of the United States have been published by the present writer. That of Jordan and Copeland, † published in 1876, enumerates 670 species. That of Jordan ‡ in 1878 contains 665 species, and that of Jordan § in 1885, 587 species, although upwards of 75 new species were detected in the nine years which elapsed between the first and the last list. Additional specimens from intervening localities are often found to form connecting links among the nominal species, and thus several supposed species become in time

* Thus the chub-sucker (*Erimyzon sucetta*) in some of its varieties ranges everywhere from Maine to Dakota, Florida and Texas; while a number of other species are scarcely less widely distributed.

† Check List of the Fishes of the Fresh Waters of North America, by David S. Jordan and Herbert E. Copeland. Bulletin of the Buffalo Society of Natural History, 1876, pp. 133–164.

‡ A Catalogue of the Fishes of the Fresh Waters of North America. Bulletin of the United States Geological Survey, 1878, pp. 407–442.

§ A Catalogue of the Fishes known to inhabit the Waters of North America North of the Tropic of Cancer. Annual Report of the Commissioners of Fish and Fisheries for 1884 and 1885.

merged in one. Thus the common channel catfish (*Ictalurus punctatus* Rafinesque) of our rivers has been described as a new species not less than twenty-five times, on account of differences, real or imaginary, but comparatively trifling in value.

Where species can readily migrate, their uniformity is preserved ; but whenever a form becomes localized its representatives assume some characters not shared by the species as a whole.

Comparing a dozen fresh specimens of almost any kind of fish from any body of water with an equal number from somewhere else, one will rarely fail to find some sort of differences —in size, in form, in color. These differences are obviously the reflex of differences in the environment, and the collector of fishes seldom fails to recognize them as such ; often it is not difficult to refer the effect to the conditions. Thus, fishes from grassy bottoms are darker than those taken from over sand, and those from a bottom of muck are darker still, the shade of color being, in some way not well understood, dependent on the color of the surroundings. Fishes in large bodies of water reach a larger size than the same species in smaller streams or ponds. Fishes from foul or sediment-laden waters are paler in color and slenderer in form than those from waters which are clear and pure. Again, it is often true that specimens from northern waters are less slender in body than those from farther south ; and so on. Other things being equal, the more remote the localities from each other, the greater are these differences.

It is evident, from these and other facts, that the idea of a separate creation for each species of fishes in each river basin, as entertained by Agassiz, is wholly incompatible with our present knowledge of the specific distinctions or of the geographical distribution of fishes. This is an unbroken gradation in the variations from the least to the greatest—from the peculiarities of the individual, through local varieties, geographical sub-species, species, sub-genera, genera, families, super-families, and so on, until all fish-like vertebrates are included in a single bond of union.

It is, however, evident that not all American types of fishes had their origin in America, or even first assumed in America

their present forms. Some of these are perhaps immigrants from Northern Asia, where they still have their nearest relatives. Still others are evidently modified importations from the sea; and of these some are very recent immigrants, land-locked species which have changed very little from the parent stock.

We can say, in general, that in all waters not absolutely uninhabitable there are fishes. The processes of natural selection have given to each kind of river or lake species of fishes adapted to the conditions of life which obtain there. There is no condition of water, of bottom, of depth, of speed of current, but finds some species with characters adjusted to it. These adjustments are, for the most part, of long standing; and the fauna of any single stream has, as a rule, been produced by immigration from other regions or from other streams. Each species has an ascertainable range of distribution, and within this range we may be reasonably certain to find it in any suitable waters.

But every species has beyond question some sort of limit to its distribution, some sort of barrier which it has never passed in all the years of its existence. That this is true becomes evident when we compare the fish-faunæ of widely separated rivers. Thus the Sacramento, Connecticut, Rio Grande and St. John's rivers have not a single species in common; and with one or two exceptions, not a species is common to any two of them. None of these has any species peculiar to itself, and each shares a large part of its fish-fauna with the water-basin next to it. It is probably true that the faunæ of no two distinct hydrographic basins are wholly identical, while, on the other hand, there are very few species confined to a single one. The supposed cases of this character, some twenty in number, occur chiefly in the streams of the South Atlantic States and of Arizona. All of these need, however, the confirmation of further exploration. It is certain that in no case has an entire river fauna originated independently from the divergence into separate species of the descendants of a single type.

The existence of boundaries to the range of species implies, therefore, the existence of barriers to their diffusion. We may

now consider these barriers, and, in the same connection, the degree to which they may be overcome.

Least important of these are the barriers which may exist within the limits of any single basin, and which tend to prevent a free diffusion through its waters of species inhabiting any portion of it. In streams flowing southward, or across different parallels of latitude, the difference in climate becomes a matter of importance. The distribution of species is governed very largely by the temperature of the water. Each species has its range in this respect—the free-swimming fishes, notably the trout, being most affected by it; the mud-loving or bottom fishes, like the catfishes, least. The latter can reach the cool bottoms in hot weather, or the warm bottoms in cold weather, thus keeping their own temperature more even than that of the surface of the water. Although water communication is perfectly free for most of the length of the Mississippi, there is a material difference between the faunæ of the stream in Minnesota and in Louisiana. This difference is caused chiefly by the difference in temperature occupying the difference in latitude. That a similar difference in longitude, with free water communication, has no appreciable importance, is shown by the almost absolute identity of the fish-faunæ of Lake Winnebago and Lake Champlain. While many large fishes range freely up and down the Mississippi, a majority of the species do not do so, and the fauna of the upper Mississippi has more in common with that of the tributaries of Lake Michigan than it has with that of the Red river or the Arkansas. The influence of climate is again shown in the paucity of the fauna of the cold waters of Lake Superior, as compared with that of Lake Michigan. The majority of our species cannot endure the cold. In general, therefore, cold or Northern waters contain fewer species than Southern waters do, though the number of individuals of any one kind may be greater. This is shown in all waters, fresh or salt. The fisheries of the Northern seas are more extensive than those of the Tropics. There are more fishes there, but they are far less varied in kind. The writer once caught seventy-five species of fishes in a single haul of the seine at Key West, while on Cape Cod he obtained with the

same net but forty-five species in the course of a week's work. Thus it comes that the angler, contented with many fishes of few kinds, goes to Northern streams to fish, while the naturalist goes to the South.

But in most streams the difference in latitude is insignificant, and the chief differences in temperature come from differences in elevation, or from the distance of the waters from the colder source. Often the lowland waters are so different in character as to produce a marked change in the quality of their fauna. These lowland waters may form a barrier to the free movements of upland fishes; but that this barrier is not impassable is shown by the identity of the fishes in the streams (for example, Elk river, Duck river, etc.) of the uplands of middle Tennessee with those of the Holston and French Broad. Again, streams of the Ozark Mountains, similar in character to the rivers of East Tennessee, have an essentially similar fish-fauna, although between the Ozarks and the Cumberland range lies an area of lowland bayous, into which such fishes are never known to penetrate. We can, however, imagine that these upland fishes may be sometimes swept down from one side or the other into the Mississippi, from which they might ascend on the other side. But such transfers certainly do not often happen. This is apparent from the fact that the two faunæ* are not quite identical, and in some cases the same species are represented by perceptibly different varieties on one side and the other. The time of the commingling of these faunæ is perhaps now past, and it may have occurred only when the climate of the intervening regions was colder than at present.

The effect of waterfalls and cascades as a barrier to the diffusion of most species is self-evident; but the importance of such obstacles is less, in the course of time, than might be expected. In one way or another very many species have

* There are three species of darters (*Etheostoma copelandi* Jordan; *Etheostoma evides* Jordan and Copeland: *Etheostoma scierum* Swain) which are now known only from the Ozark region or beyond and from the uplands of Indiana, not yet having been found at any point between Indiana and Missouri. These constitute perhaps isolated colonies, now separated from the parent stock in Arkansas by the prairie districts of Illinois, a region at present uninhabitable for these fishes. But the non-occurrence of these species over the intervening areas needs confirmation, as do most similar cases of anomalous distribution.

passed these barriers. The falls of the Cumberland limit the range of most of the larger fishes of the river, but the streams above it have their quota of darters and minnows. It is evident that the past history of the stream must enter as a factor into this discussion, but this past history it is not always possible to trace. Dams or artificial waterfalls now check the free movement of many species, especially those of migratory habits; while, conversely, numerous other species have extended their range through the agency of canals (thus, *Dorosoma cepedianum* Le Sueur, and *Clupea chrysochloris* Rafinesque, have found their way into Lake Michigan through canals).

Every year fishes are swept down the rivers by the winter's floods; and in the spring, as the spawning season approaches, almost every species is found working its way up the stream. In some cases, notably the Quinnat salmon (*Oncorhynchus tschawytscha* Walbaum) and the blueback salmon (*Oncorhynchus nerka* Walbaum), the length of these migrations is surprisingly great. To some species rapids and shallows have proved a sufficient barrier, and other kinds have been kept back by unfavorable conditions of various sorts. Streams whose waters are always charged with silt or sediment, as the Missouri, Arkansas, or Brazos, do not invite fishes; and even the occasional floods of red mud such as disfigure otherwise clear streams, like the Red river or the Colorado (of Texas), are unfavorable. Extremely unfavorable also is the condition which obtains in many rivers of the Southwest; as for example, the Red river, the Sabine, and the Trinity, which are full from bank to bank in winter and spring, and which dwindle to mere rivulets in the autumn droughts.

In general, those streams which have conditions most favorable to fish-life will be found to contain the greatest number of species. Such streams invite immigration; and in them the struggle for existence is individual against individual, species against species, and not a mere struggle with hard conditions of life. Some of the conditions most favorable to the existence in any stream of a large number of species of fishes are the following, the most important of which is the one mentioned first: connection with a large hydrographic basin; a warm climate;

clear water; a moderate current; a bottom of gravel (preferably covered by a growth of weeds); little fluctuation during the year in the volume of the stream or in the character of the water.

Limestone streams usually yield more species than streams flowing over sandstone, and either more than the streams of regions having metamorphic rocks. Sandy bottoms usually are not favorable to fishes. In general, glacial drift makes a suitable river bottom, but the higher temperature usual in regions beyond the limits of the drift gives to certain Southern streams conditions still more favorable. These conditions are all well realized in the Washita river in Arkansas, and in various tributaries of the Tennessee, Cumberland and Ohio; and in these, among American streams, the greatest number of species has been recorded.

The isolation and the low temperature of the rivers of New England have given to them a very scanty fish-fauna as compared with the rivers of the South and West. This fact has been noticed by Professor Agassiz, who has called New England a "zoölogical island." *

In spite of the fact that barriers of every sort are sometimes crossed by fresh-water fishes, we must still regard the matter of freedom of water communication as the essential one in determining the range of most species. The larger the river basin, the greater the variety of conditions likely to be offered in it, and the greater the number of its species. In case of the divergence of new forms by the processes called "natural selection," the greater the number of such forms which may have spread through its waters; the more extended any river basin, the greater are the chances that any given species may sometime find its way into it; hence the greater the number of species that actually occur in it, and, freedom of movement being assumed, the greater the number of species to be found in any one of its affluents.

* "In this isolated region of North America, in this zoölogical island of New England, as we may call it, we find neither Lepidosteus, nor Amia, nor Polyodon, nor Amblodon (*Aplodinotus*), nor Grystes (*Micropterus*), nor Centrarchus, nor Pomoxis, nor Ambloplites, nor Calliurus (*Chænobryttus*), nor Carpiodes, nor Hyodon, nor indeed any of the characteristic forms of North American fishes so common everywhere else, with the exception of two Pomotis (*Lepomis*), one Boleosoma, and a few Catostomus."—Agassiz, *Amer. Journ. Sci. Arts*, 1854.

Of the six hundred species of fishes found in the rivers of the United States, about two hundred have been recorded from the basin of the Mississippi. From fifty to one hundred of these species can be found in any one of the tributary streams of the size, say, of the Housatonic river or the Charles. In the Connecticut river there are about eighteen species permanently resident; and the number found in the streams of Texas is not much larger, the best-known of these, the Rio Colorado, having yielded but twenty-four species.

The waters of the Great Basin have not yet been fully explored. The number of species now known from this region is about seventy-five. This number includes the fauna of the upper Rio Grande, the Snake river, and the Colorado, as well as the fishes of the tributaries of the Great Salt Lake. This list is composed almost entirely of a few genera of suckers (*Catostomus*, *Pantosteus*, *Chasmistes*), minnows (*Squalius*, *Gila*, *Ptychocheilus*, etc.), and trout (*Salmo mykiss* and its varieties). None of the catfishes, perch, darters, or sunfishes, moon-eyes, killifishes, and none of the ordinary Eastern types of minnows (genera *Notropis*, *Chrosomus*, etc.) have passed the barrier of the Rocky Mountains.

West of the Sierra Nevada, the fauna is still more scanty, but fifty species being enumerated. This fauna, except for certain immigrants (as the fresh water surf-fish [*Hysterocarpus traski*] and the species of salmon) from the sea, is of the same general character as that of the Great Basin, though most of the species are different. This latter fact would indicate a considerable change, or "evolution," since the contents of the two faunæ were last mingled. There is a considerable difference between the fauna of the Columbia and that of the Sacramento. The species which these two basins have in common are chiefly those which at times pass out into the sea. The rivers of Alaska contain but few species, barely a dozen in all, most of these being found also in Siberia and Kamtschatka. In the scantiness of its faunal list, the Yukon agrees with the Mackenzie river, and with Arctic rivers generally.

There can be no doubt that the general tendency is for each species to extend its range more and more widely until all local-

ities suitable for its growth are included. The various agencies of dispersal which have existed in the past are still in operation. There is apparently no limit to their action. It is probable that new "colonies" of one species or another may be planted each year in waters not heretofore inhabited by such species. But such colonies become permanent only where the conditions are so favorable that the species can hold its own in the struggle for food and subsistence. That various modifications in the habitat of certain species have been caused by human agencies is of course too well known to need discussion here.

We may next consider the question of water-sheds, or barriers which separate one river basin from another.

Of such barriers in the United States, the most important and most effective is unquestionably that of the main chain of the Rocky Mountains. This is due in part to its great height, still more to its great breadth, and most of all, perhaps, to the fact that it is nowhere broken by the passage of a river. But two species—the red-throated, or Rocky Mountain trout (*Salmo mykiss* Walbaum [=*purpuratus* Pallas],) and the Rocky Mountain whitefish (*Coregonus williamsoni* Girard)—are found on both sides of it, at least within the limits of the United States; while many genera, and even several families, find in it either an eastern or a western limit to their range. In a few instances representative species, probably modifications or separated branches of the same stock, occur on opposite sides of the range, but there are not many cases of correspondence even thus close.

It is easy to account for the separation of the faunæ; but how shall we explain the almost universal diffusion of the whitefish and the trout in suitable waters on both sides of the dividing ridge? We may notice that these two are the species which ascend highest in the mountains, the whitefish inhabiting the mountain pools and lakes, the trout ascending all brooks and rapids in search of their fountain-heads. In many cases the ultimate dividing ridge is not very broad, and we may imagine that at some time spawn or even young fishes may have been carried across by birds or other animals, or by man, —or more likely by the dash of some summer whirlwind.

Once carried across in favorable circumstances, the species might survive and spread.

I have seen an example of how such transfer of species may be accomplished, which shows that we need not be left to draw on the imagination to invent possible means of transit.

There are few water-sheds in the world better defined than the mountain range which forms the "backbone" of Norway. I lately climbed a peak in this range, the Suletind. From its summit I could look down into the valleys of the Lära and the Bägna, flowing in opposite directions to opposite sides of the peninsula. To the north of the Suletind is a large double lake called the Sletningenvand. The maps show this lake to be one of the chief sources of the westward-flowing river Lära. This lake is in August swollen by the melting of the snows, and at the time of my visit it was visibly the source of both these rivers. From its southeastern side flowed a large brook into the valley of the Bägna, and from its southwestern corner, equally distinctly, came the waters which fed the Lära. This lake, like similar mountain ponds in all northern countries, abounds in trout; and these trout certainly have for part of the year an uninterrupted line of water communication from the Sognefjord on the west of Norway to the Christianiatjord on the southeast,—from the North Sea to the Baltic. Part of the year the lake has probably but a single outlet through the Lära. A higher temperature would entirely cut off the flow into the Bägna, and a still higher one might dry up the lake altogether. This Sletningenvand,* with its two outlets on the summit of a sharp water-shed, may serve to show us how other lakes, permanent or temporary, may elsewhere have acted as agencies for the transfer

* Since the above was written I have been informed by Professor John M. Coulter, who was one of the first explorers of the Yellowstone Park, that such a condition still exists on the Rocky Mountain Divide. In the Yellowstone Park is a marshy tract, traversable by fishes in the rainy season, and known as the "Two-Ocean Water" In this tract rise tributaries both of the Snake river and of the Yellowstone. Similar conditions apparently exist on other parts of the Divide, both in Montana and in Wyoming.

Professor John C. Branner calls my attention to a marshy upland which separates the valley of the La Plata from that of the Amazon, and which permits the free movement of fishes from the Paraguay river to the Tapajos. It is well known that through the Cassiquiare river the Rio Negro, another branch of the Amazon, is joined to the Orinoco river. It is thus evident that almost all the waters of eastern South America form a single basin, so far as the fishes are concerned.

of fishes. We can also see how it might be that certain mountain fishes should be so transferred while the fishes of the upland waters may be left behind. In some such way as this we may imagine the trout and the whitefish to have attained their present wide range in the Rocky Mountain region; and in similar manner perhaps the Eastern brook trout (*Salvelinus fontinalis* Mitchill) and some other mountain species (*Notropis rubricroceus* Cope; *Rhinichthys atronasus* Mitchill, etc.) may have been carried across the Alleghanies.

The Sierra Nevada constitutes also a very important barrier to the diffusion of species. This is, however, broken by the passage of the Columbia river, and many species thus find their way across it. That the waters to the west of it are not unfavorable for the growth of eastern fishes is shown by the fact of the rapid spread of the common eastern catfish (*Ameiurus nebulosus* Le Sueur) or horned pout, when transported from the Schuylkill to the Sacramento. This fish is now one of the important food-fishes of the San Francisco markets. It has become in fact, an especial favorite with the Chinaman,—himself also an immigrant, and presenting certain analogies with the fish in question, as well in temperament as in habits.

The mountain mass of Mount Shasta is, as already stated, a considerable barrier to the range of fishes, though a number of species find their way around it through the sea. The lower and irregular ridges of the Coast Range are of small importance in this regard, as the streams of their east slope reach the sea on the west through San Francisco Bay. Yet the San Joaquin contains a few species, not yet recorded, from the smaller rivers of southwestern California.

The main chain of the Alleghanies forms a barrier of importance separating the rich fish-fauna of the Tennessee and Ohio basins from the scantier faunæ of the Atlantic streams. Yet this barrier is crossed by many more species than is the case with either the Rocky Mountains or the Sierra Nevada. It is lower, narrower, and much more broken, —as in New York, in Pennsylvania, and in Georgia there are several streams which pass through it or around it. The much greater age of the Alleghany chain, as compared with the

Rocky Mountains, seems not to be an element of any importance in this connection. Of the fish which cross this chain, the most prominent is the brook trout (*Salvelinus fontinalis*), which is found in all suitable waters from Hudson's Bay to the head of the Chattahoochee. A few other species are locally found in the headwaters of certain streams on opposite sides of the range. An example of this is the little red "fall-fish" (*Notrobis rubricroceus* Cope), found only in the mountain tributaries of the Savannah and the Tennessee. We may suppose the same agencies to have assisted these species that we have imagined in the case of the Rocky Mountain trout, and such agencies were doubtless more operative in the times immediately following the glacial epoch than they are now.

The passage of species from stream to stream along the Atlantic slope deserves a moment's notice. It is, under present conditions, impossible for any mountain or upland fish, as the trout or the miller's thumb (*Cottus richardsoni* Agassiz), to cross from the Potomac river to the James, or from the Neuse to the Santee, by descending to the lower courses of the rivers, and thence passing along either through the swamps or by way of the sea. The lower courses of these streams, warm and muddy, are uninhabitable by such fishes. Such transfers are, however, possible farther north. From the rivers of Canada and from many rivers of New England the trout does descend to the sea and into the sea, and farther north the whitefish does this also. Thus these fishes readily pass from one river basin to another. As this is the case now everywhere in the North, it may have been the case farther south in the time of the glacial cold. We may, I think, imagine a condition of things in which the snow-fields of the Alleghany chain might have played some part in aiding the diffusion of cold-loving fishes. A permanent snow-field on the Blue Ridge in western North Carolina might render almost any stream in the Carolinas suitable for trout, from its source to its mouth. An increased volume of colder water might carry the trout of the head-streams of the Catawba and the Savannah as far down as the sea. We can even imagine that the trout reached these streams in the first place through such agencies, though of this there is no positive evidence. For

the presence of trout in the upper Chattahoochee, we must account in some other way.

It is noteworthy that the upland fishes are nearly the same in all these streams, until we reach the southern limit of possible glacial influence. South of western North Carolina, the faunæ of the different river basins appear to be more distinct from one another. Certain ripple-loving types* are represented by closely related but unquestionably different species in each river basin, and it would appear that a thorough mingling of the upland species in these rivers has never taken place.

With the lowland species of the Southern rivers it is different. Few of these are confined within narrow limits. The streams of the whole South Atlantic and Gulf Coast flow into shallow bays, mostly bounded by sand-spits or sand-bars which the rivers themselves have brought down. In these bays the waters are often neither fresh nor salt; or rather, they are alternately fresh and salt, the former condition being that of the winter and spring. Many species descend into these bays, thus finding every facility for transfer from river to river. There is a continuous inland passage in fresh or brackish waters, traversable by such fishes, from Chesapeake Bay nearly to Cape Fear; and similar conditions exist on the coasts of Louisiana, Texas, and much of Florida. In Perdido Bay I have found fresh-water minnows (*Notropis cercostigma; Notropis xænocephalus*), and silversides (*Labidesthes sicculus*), living together with marine gobies (*Gobiosoma molestum*) and salt-water eels (*Myrophis punctatus*). Fresh-water alligator gars (*Lepisosteus tristœchus*) and marine sharks compete for the garbage thrown over from the Pensacola wharves. In Lake Pontchartrain the

* The best examples of this are the following: In the Santee basin are found *Notropis pyrrhomelas, Notropis niveus*, and *Notropis chloristius;* in the Altamaha, *Notropis xænurus* and *Notropis callisemus;* in the Chattahoochee, *Notropis hypselopterus* and *Notropis eurystomus;* in the Alabama, *Notropis cæruleus, Notropis trichroistius*, and *Notropis callistius*. In the Alabama, Escambia, Pearl, and numerous other rivers, is found *Notropis cercostigma*. This species descends to the sea in the cool streams of the pine-woods. Its range is wider than that of the others, and in the rivers of Texas it reappears in the form of a scarcely distinct variety, *Notropis venustus*. In the Tennessee and Cumberland, and in the rivers of the Ozark range, is *Notropis galacturus;* and in the upper Arkansas *Notropis camurus*—all distinct species of the same general type. Northward, in all the streams from the Potomac to the Oswego, and westward to the Des Moines and the Arkansas occurs a single species of this type, *Notropis whipplei*. But this species is not known from any of the streams inhabited by any of the other species mentioned, although very likely it is the parent stock of them all.

fauna is a remarkable mixture of fresh-water fishes from the Mississippi and marine fishes from the Gulf. Channel-cats, sharks, sea-crabs, sunfishes, and mullets can all be found there together. It is therefore to be expected that the lowland fauna of all the rivers of the Gulf States would closely resemble that of the lower Mississippi ; and this, in fact, is the case.

The low and irregular water-shed which separates the tributaries of Lake Michigan and Lake Erie from those of the Ohio is of little importance in determining the range of species. Many of the distinctively Northern fishes are found in the head-waters of the Wabash and the Scioto. The considerable difference in the general fauna of the Ohio Valley as compared with that of the streams of Michigan is due to the higher temperature of the former region, rather than to any existing barriers between the river and the Great Lakes. In northern Indiana the water-shed is often swampy, and in many places large ponds exist in the early spring.

At times of heavy rains many species will move through considerable distances by means of temporary ponds and brooks. Fishes that have thus emigrated often reach places ordinarily inaccessible, and people finding them in such localities often imagine that they have "rained down." Once, near Indianapolis, after a heavy shower, I found in a furrow in a corn-field a small pike (*Esox vermiculatus* Le Sueur), some half a mile from the creek in which he should belong. The fish was swimming along in a temporary brook, apparently wholly unconscious that he was not in his native stream. Migratory fishes, which ascend small streams to spawn, are especially likely to be transferred in this way. By some such means any of the water-sheds in Ohio, Indiana, or Illinois may be passed.

It is certain that the limits of Lake Erie and Lake Michigan were once more extended than now. It is reasonably probable that some of the territory now drained by the Wabash and the Illinois was once covered by the waters of Lake Michigan. The cisco (*Coregonus artedi sisco* Jordan), of Lake Tippecanoe, Lake Geneva, and the lakes of the Oconomowoc chain, is evidently a modified descendant of the so-called lake herring

(*Coregonus artedi* Le Sueur). Its origin most likely dates from the time when these small deep lakes of Indiana and Wisconsin were connected with Lake Michigan. The changes in habits which the cisco has undergone are considerable. The changes in external characters are but trifling. The presence of the cisco in these lakes and its periodical disappearance—that is retreat into deep water when not in the breeding season—has given rise to much nonsensical discussion as to whether any or all of these lakes are still joined to Lake Michigan by subterranean channels. Several of the larger fishes, properly characteristic of the Great Lake region (as, *Lota lota maculosa; Percopsis guttatus; Esox masquinongy*), are occasionally taken in the Ohio river, where they are usually recognized as rare stragglers. The difference in physical conditions is probably the sole cause of their scarcity in the Ohio basin.

The similarity of the fishes in the different streams and lakes of the Great Basin is doubtless to be attributed to the general mingling of their waters which took place during and after the glacial epoch. Since that period the climate in that region has grown hotter and drier, until the overflow of the various lakes into the Columbia basin through the Snake river has long since ceased. These lakes have become isolated from each other, and many of them have become salt or alkaline and therefore uninhabitable. In some of these lakes certain species may now have become extinct which still remain in others. In some cases, perhaps, the differences in surrounding may have caused divergence into distinct species of what was once one parent stock. The suckers in Lake Tahoe (*Catostomus tahoensis*, in Lake Tahoe; *Catostomus macrocheilus* and *discobolus*, in the Columbia; *Catostomus fecundus*, *Catostomus ardens; Chasmistes liorus* and *Pantosteus generosus*, in Utah Lake) and those in Utah Lake are certainly now different from each other and from those in the Columbia. The trout (*Salmo mykiss*, et vars. *henshawi* and *virginalis*) in the same waters can be regarded as more or less tangible varieties only, while the whitefishes (*Coregonus williamsoni*) show no differences at all. The differences in the present faunæ of Lake Tahoe and Utah Lake must be chiefly due to influences which

have acted since the glacial epoch, when the whole Utah Basin was part of the drainage of the Columbia.

To certain species of upland or mountain fishes, the depression of the Mississippi basin itself forms a barrier which cannot be passed. The black-spotted trout (*Salmo fario* L., in Europe; *Salmo labrax* Pallas, etc., in Asia; *Salmo gairdneri* Richardson, in streams of the Pacific Coast. *Salmo mykiss* Walbaum, in Kamtschatka, Alaska, and throughout the Rocky Mountain range to the Mexican boundary, and the headwaters of the Kansas, Platte, and Missouri), very closely related species of which abound in all waters of northern Asia, Europe, and western North America, has nowhere crossed the basin of the Mississippi, although one of its species finds no difficulty in passing Behring Strait. The trout and whitefish of the Rocky Mountain region are all species different from those of the Great Lakes or the streams of the Alleghany system. To the grayling, the trout, the whitefish, the pike, and to arctic and sub-arctic species generally, Behring Strait has evidently proved no serious obstacle to diffusion; and it is not unlikely that much of the close resemblance of the fresh-water faunæ of northern Europe, Asia and North America is due to this fact. To attempt to decide from which side the first migration came in regard to each group of fishes might be interesting; but without a wider range of facts than is now in our possession, such attempts would be mere guesswork and without value. The interlocking of the fish-faunæ of Asia and North America presents, however, a number of interesting problems, for numerous migrations in both directions have doubtless taken place.

I could go on indefinitely with the discussion of special cases, each more or less interesting or suggestive in itself, but the general conclusion is in all cases the same.

The present distribution of fishes is the result of long-continued action of forces still in operation. The species have entered our waters in many invasions from the Old World, or from the sea. Each species has been subjected to the various influences implied in the term natural selection, and under varying conditions, its representatives have undergone many different modifications.

Each of the 600 species we now know is making every year inroads on territory occupied by other species. If these colonies are able to hold their own in the struggle for possession, they will multiply in the new conditions and the range of the species will become widened. If the surroundings are different new species or varieties may be formed in time and these new forms may again invade the territory of the parent species. Again colony after colony of species after species may be destroyed by other species or by uncongenial surroundings.

The ultimate result of centuries on centuries of the restlessness of individuals is seen in the facts of geographical distribution. Only in the most general way can the history of any species be traced. Could we know it all, it would be as long and eventful a story as the history of the colonization and settlement of North America by immigrants from Europe.

By the fishes each river in America has been a hundred times discovered ; its colonization a hundred times attempted. In these efforts there is no co-operation. Every individual is for himself, every struggle is a struggle of life and death. Each fish is a cannibal, and to each species each member of every other species is an alien and a savage. Now all this has a practical side to it, although the practical side has been as yet little developed.

A leading feature of the work of the Fish Commissions must be to help the fishes over the barriers, to assist nature in the direction of colonizing streams and lakes with fishes which are good to eat, to the exclusion of the kinds of which man can make no use.

This help may be given by the introduction of vigorous kinds of fishes into waters into which they had been unable to find an entrance before. The work judiciously done may be of the greatest value to the people of our country. Numerous as are the food fishes of the Mississippi valley, it must be confessed that the rank of the great bulk of them is not high. Our rivers ought to raise something better than suckers, paddle-fish, drum and buffaloes. To bring in better fishes with success, it is necessary for us to know something of the habits and necessities of the species in question, and also something definite as to the

character of the waters which are to be stocked. It is of no use to plant brook trout in a muddy bayou, or channel-cat in mountain springs of ice-water, or codfish in Lake Michigan.

Most of our information in these respects is still very vague, and most attempts at the introduction of species into new waters are still of the most haphazard sort. The recent series of examinations of the Michigan lakes, lately undertaken by the Michigan State Fish Commission, ought to yield some results in this connection, yet as the character of the waters of the State is essentially uniform, what is true of one of the little lakes in the way of supporting fish life, must be largely true of all. For this reason, desirable as an extended exploration is from an economic standpoint, it can be made more important to the science of ichthyology, than to the art of fish-culture. To ichthyology, as has been said, a sculpin is as valuable as a codfish, but fish-culture prefers the codfish.

The results of a careful survey would give us facts regarding the distribution of minnows, darters and sunfish, facts of the greatest interest and importance in science, but of no value to fish-culture to which one minnow is as good as another and both useful only as food for bass, still a thorough survey in the hands of intelligent men, of the waters of any region cannot fail to throw much light on the habits and needs of the various food fishes, and we shall look with much interest for the final results of the work in Michigan.

The other work of the Fish Commission is in the direction of fish-hatching, the protection of the young of valuable kinds until they are able to take care of themselves. The value of this work is most great, now fortunately beyond question, and its methods are reaching a high degree of perfection.

I need only say that my deepest interest in science lies in the direction of the question of the distribution of organisms and in their adaptation to their surroundings and I should be glad if I were able to contribute even a little to making our knowledge of this subject practicably available in the direction of causing two big fish to grow where one little one grew before.

Indiana State University, Bloomington, Ind.

DR. SWEENY said that the "dogfish" referred to by Prof. Jordan are considered a superior fish by the Hebrews of Minnesota, who call them "green bass." They are also called "lawyers," because they clean up everything.

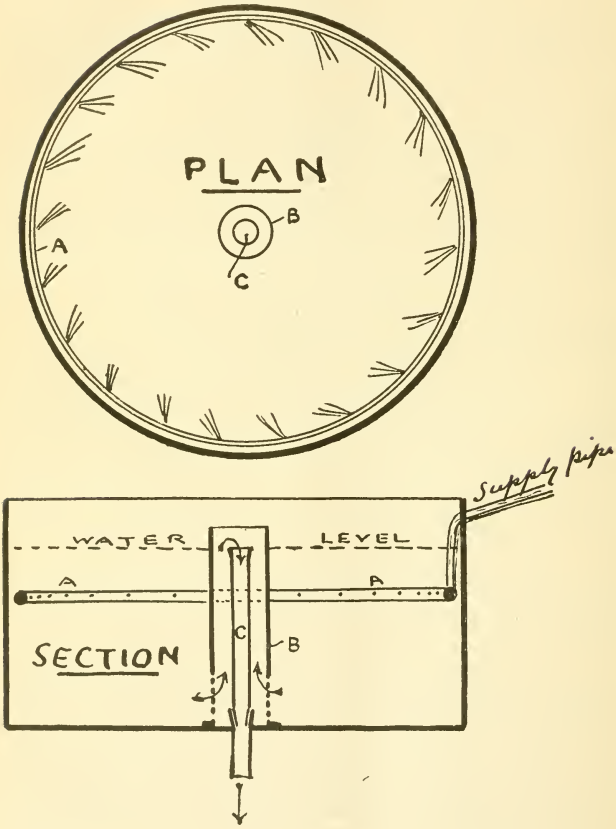
DR. J. C. PARKER had noted what Prof. Jordan said about the bullheads in East Coy creek. He had put his hands on them. They were transported from Silver Lake and placed in a horse trough at first and then escaped into the creek. There were no bullheads there during his boyhood.

MR. MATHER announced that he had received a private letter from Mr. W. Oldham Chambers, Secretary of the National Fish-culture Association of England, dated April 22, 1888, which contained some matters of public interest, and he would read such portions of it as related to the rearing of fishes. Mr. Chambers says: "I am looking forward to a visit to America, some time, for the express purpose of studying the vast advances you are making in our glorious science. I can conceive no greater treat than to exchange thoughts with my transatlantic friends. I think there is this difference, if I am not mistaken, in our methods; you devote all your energies to hatch out the greatest quantity of fry and then turn them out in the rivers and lakes, whereas we try to invent means of feeding and rearing them after the sac is absorbed, and then turn them out when they are capable of caring for themselves. I have never met with anything that approaches my "thorough" system of feeding. You can make a vase to bring up 100, or one large enough for 100,000 with the same ease, and on the same principle. The fish are bound to be on the move and are equally bound to feed, because the food is always held in suspension and has no chance to get to the bottom. I inclose a sketch, to scale similar to one in my hatchery that now has 15,000 rainbow trout in it. Oblige me by making one, which you can do at a small cost, and give me an opinion of the result. There is no patent on it, so do what you like with it. Be careful to follow the lines laid down in the inclosed diagram, especially in the case of the holes in the pipe which must be at the proper angle, for there rests the secret."

MR. CHAMBERS' "THOROUGH" VASE.

SCALE, 1 INCH TO THE FOOT.

(Cut loaned by *Forest and Stream.*)



A, Supply pipe.
B Guard cylinder with perforated bottom.
C, Standing waste, ground into fixed waste.

SPECIFICATIONS OF "THOROUGH" VASE.

"The outer casing can be an ordinary wooden tub, one three feet in diameter will hold 10,000 fry. The supply pipe to be one-half inch lead composition, to be fixed three-quarter inch away from inside of tub. This pipe to be perforated about every four inches with very fine holes, which must be at an angle as shown; the water as it enters this tub is forced round and round and the fish are in a small trout stream; the food is also kept in suspension by the circular motion.

"The guard cylinder is tacked to the bottom of the tub by a small flange. This cylinder is made with zinc, but the bottom four inches is perforated zinc, the waste water, dirt, etc., passes through the perforations.

"The standing waste to be one and one-quarter inch lead pipe, the top slightly bell-mouthed, the bottom soldered to a brass piece with ground face, which fits into a brass fixture standing up one inch from bottom of tub with corresponding ground face.

"In washing out pull up the standing waste and with a feather stir up the bottom of tub and away goes the sediment down the waste. You seldom want to do this with care in feeding, not to give too much at a time.

"Remember that the entire invention depends upon the holes in circulating supply pipe being pierced at the proper angle."

MR. MATHER said that all his trout were distributed or put out in the rearing ponds and he could not try this method the present year, but it may be worth while for others to do it. In 1880, when on the staff of Prof. G. Brown Goode, in charge of the American department at the fisheries exhibition in Berlin, a gentleman from Baltimore, whose name he had momentarily forgotten, sent some glass models of the Bell and Mather shad hatching cones which were designed to keep the food in suspension, just as the shad eggs are, and some fry were fed in the cones for a while, but not long enough to test the system of

keeping food in suspension, nor to develop any difficulty which might arise from decaying food.

Reports of the Northern Fisheries Society of Japan were shown, and a translation of the headings of the articles read, as was also a letter from the president of that society, Mr. K. Ito, who called attention to some translated extracts from *Forest and Stream*, and to a portrait of Prof. G. Brown Goode, which adorned one of the reports.

A letter from Mr. Seth Green was read but was carried off by some of the reporters. He commended the work of the society and congratulated the Michigan Commission in having an able Superintendent in Mr. Walter D. Marks. He also announced that Jonathan Mason had succeeded in hatching the mascalonge at Chautauqua Lake, N. Y., the first of this species to be artificially hatched.

THE LATE PROF. SPENCER F. BAIRD.

Dr. W. M. Hudson moved that a committee be appointed to draft a resolution of regret at the death of Prof. S. F. Baird, and the president named Dr. Hudson, Dr. Sweeny and Mr. J. H. Bissell as such committee. Later on they reported the following, which was accepted by the Society :

IN MEMORY OF SPENCER F. BAIRD.

. "Since the last meeting of this Society, our associate, Prof. Spencer F. Baird, United States Commissioner, has been removed from the scene of his labors by death. This Society hereby puts on record its appreciation of the great efficiency and admirable administrative qualifications by which he caused the position of U. S. Commissioner to be regarded as the first in the entire world, and mourns the loss of one who by his lovable qualities had endeared himself to all who came in contact with him."

Mr. William Alden Smith, fish and game warden for the State of Michigan, spoke on the regulation of the fisheries, outlining the work of his 180 deputies and himself in executing

the laws protecting fish and game. "We have generally had hearty and generous co-operation," he said. "In Eaton County four prominent citizens were convicted of violating the laws, despite the fact that the evidence was not conclusive, and they were given the full penalty of the law. In the County of Clare we were given the greatest opposition. A deputy came upon a man spearing fish. The violator refused to submit to arrest. The deputy lugged him off eight miles to a justice, where he was speedily acquitted. The work of enforcing the laws has been studiously carried on. The people demand their execution and the results are gratifying to all."

THE PROPAGATION OF NATURAL FOOD FOR FISH, WITH SPECIAL REFERENCE TO FISH-CULTURE.

BY M. E. O'BRIEN.

The subject "natural food of fish" is one that has received but meagre attention from the older naturalists, and our knowledge regarding this most important factor in fish-culture is but in its infancy, merely a passing glance having been bestowed on it by both naturalists and fish-culturists of the present day. Undoubtedly much good work has been done within the last five years towards investigating the food of the various species of marine food-fish, the result of examinations made on fish caught by steam trawlers and line boats; but in reference to fresh-water species, migratory and non-migratory, as far as I am aware, little effort has been made in this direction.

The present system of aiding the growth and development of fish by supplying them with various kinds of artificial foods, such as liver, coagulated blood, vegetables, etc., may produce results of a kind, but it is a system open to many objections.

First—It is unnatural.

Second—It has a tendency to render the water putrid, and consequently injurious to fish.

Third—It favors the introduction of disease.

Fourth—And last but not least, it entails a great deal of expense.

The results of such artificial feeding are found not to correspond to its cost, and this fact deters many people from engaging in the rearing of fish who would otherwise do so. All the results of artificial feeding are based more or less on hypothesis, because in making experiments the natural food, both animal and vegetable, has in most cases nowhere been investigated or taken into account. Now, I am sure no one will deny that it is better, if possible, to stick to the natural food, and give the powerful productions of nature a chance of exercising their beneficial influence. What I wish to bring before your immediate notice is this: "That at a comparatively small cost, conditions closely approximating those of nature can be established, under which conditions various forms of natural fish food will live, thrive and multiply, so as to afford a continual increasing supply of nutriment to the fish."

For the past two years I have been making investigations to find if possible some means by which fish, confined in small ponds could be supplied with natural food. My first step was to find out what the fish fed upon, and this led me to examine the stomach contents of numerous fish during the different seasons of the year. I confined my investigations to that most interesting class—the salmonidæ (*Salmo fontinalis* and *Salmo irideus*). What may be termed a post-mortem examination was performed—slitting the fish along its ventral or belly aspect, thus exposing the alimentary tract, I tied two ligatures, one around the gullet, the other round the intestine near the pyloric, or lesser end of the stomach. Removing the portion between the two ligatures, I opened the stomach and extracted the contents, placing them on a white plate. These I examined both by aid of the naked eye and microscope, then deposited them in a glass vial containing rectified spirits, and affixed a seal and label indicating the kind of food and date of examination. Thus at the end of the season I had quite an array of bottles containing different species of natural fish food.

The majority of the food belonged to the invertebrate type, including various species of crustacea, insecta, worms, leeches,

and mollusca. Some of these the fish seemed to prefer at a certain season of the year to the exclusion of the others; thus I found the ordinary univalve shellfish (*Limnæa stagnalis*), a very frequent customer during the summer months, a decided favorite with both the *Salmo fontinalis* and *Salmo irideus*. This shellfish exists in enormous quantities in the lakes and quiet pools of rivers, and is greedily devoured by the trout. They feed on aquatic plants on whose stems they creep, and come occasionally to the surface to respire. In their reproduction the same limnæa is capable of serving at the same time as a male for a second, and as a female for a third, and by this connection of one individual with two others a continuous chain of some length is not unfrequently produced. The number of eggs is prodigious, and they are deposited on stones, stems of plants, etc., in elongated masses enveloped in a glary substance, very much similar in appearance to that which surrounds the ova of the frog. In their adult condition they love to crawl about on a gravelly bottom. Other genera, such as planorbis, cytilus and ancyllus, used to turn up on various occasions. These mollusca are a valuable source of nutriment to fish, having a double function, being composed of two parts, viz.: the fleshy portion or animal, which is a delicacy in itself, and its outer covering or shell, which, from its containing a large proportion of carbonate of lime, promotes the strength and growth of the fish.

Of crustacea, the common fresh water sand-hopper (*Gammarus pulex*) was invariably to be found. It abounds in almost all springs, ponds and rivulets, swimming near the bottom on its side. It feeds principally on dead material, and, like the limnæa, reproduces itseif in enormous quantities. As a diet, it seems to cause a deeper color in the flesh of the fish. Most of the larger trout like to feed on material more in proportion to their size; thus, in the summer months, the frog and tadpole are particularly sought after as a bill of fare. Various species of insecta both in their larval and adult conditions, worms and a small brownish black leech, are also in my list of stomach contents.

Now, as an adjunct to a fish pond, it seems to me that some

of the above types could be reared in such quantities as to form a good and economical source of nutriment for fish. These lower types undoubtedly require certain conditions for their healthy existence, and what I propose is this: Trenches, or basins, should be dug in close apposition with the ponds, and, if necessary, communicating with them. These basins to be supplied with spring water by means of a pipe connected with the main spring. One should be devoted to Shell culture, another to Insect culture, and a third to Crustacea, and so on.

These various foods could be transferred by means of a fine net, or better still, by a running stream of water communicating with the fish pond, or means could be established whereby these forms could creep from the basin into the pond. By this method the fish-culturist would know exactly how much food the fish were getting, and he would also be able to arrive at some estimation as to the comparative nutritiousness of the various forms of natural food. Suitable conditions could be produced whereby insects about to deposit their eggs might be attracted, and soon the basins would swarm with larvæ, which form an excellent food, especially for young fish. As in human economy the food of the child requires to be different from that of the adult; so in like manner does the food of the young fish require to be different from that of the adult fish.

One word more, and that is regarding the frog. Should it be admitted into the arena of fish-culture? I think so. The damage it does to small fry can be kept within limits. A small pond could be constructed with an arrangement to prevent its escape, and in this pond the cultivation of the tadpole could be prosecuted, and for a time an abundant supply of stronger food would be afforded, for the large fish. Should the above experiments be tried and meet with success, they will establish the economic value of natural food as opposed to the artificial system of feeding; increase the number of fish culturists, and, in addition, afford a means of studying the life history of these lower forms, in connection with which are many points of great scientific interest requiring elucidation.

South Bend, Nebraska.

Mr. Mather remarked that he agreed with Mr. O'Brien that natural food was the best ; but the trouble was to produce it in quantity sufficient for the daily food of a hundred thousand fry. He had a reservoir, about 300 by 30 feet, which supplied the hatching, and here he usually planted about 6,000 trout-fry, which found sufficient food during the summer, and outgrew those which were fed on clams and mussels, which, by the way, is the best food he ever used, and, in October, he drew this reservoir down and took out from 1,500 to 2,000 fine young trout ; but it was doubtful if the water would grow many more.

SOME OBSERVATIONS ON THE BLACK BASS.

BY C. F. HOLT.

Having resided for the past thirty-five years on the bank of the Thornapple river, a favorite resort for that king of Michigan game fish, the small-mouthed black bass, I have had ample opportunities of studying their habits, and for the past few years have given the matter considerable attention.

They leave their winter quarters, usually under heaps of drift-wood or in hollow sunken logs, about the middle of April, and in a short time repair to their spawning grounds. I am quite sure that they pass the winter in hollow, sunken logs whenever they can, for, about the first of April, 1885, while removing some drift-wood from the river, we took out one hollow log that contained eighteen small-mouth black bass, weighing from two to three pounds each ; and again this year, at about the same time, I found six more under the same conditions. The spawning season here begins the last week in April. The first bed seen in 1885 was on April 28 ; in 1886, April 24 ; and in 1887 and 1888, April 26. The places selected are in nearly still water, near the shore, and in water from one to two feet in depth.

The beds are circular in form, from eighteen inches to three feet in diameter, and are formed by cleaning from the bottom all sediment, sand, etc., leaving a bed of clean pebbles. This is the joint work of both male and female fish. The bed having

been prepared, the female then moves slowly over it, depositing her ova, and the male impregnates them as fast as laid. The eggs, which are very small, are glued fast to the pebbles. The impregnation is almost absolutely perfect. In the past three years I have examined a large number of beds, by carefully removing one or more of the pebbles covered with eggs, and examining them with a microscope, and have never yet found more than one per cent. of unimpregnated eggs.

After the eggs are impregnated the male leaves to the female the whole care of the eggs and the young brood. She now passes constantly backwards and forwards over the bed, the motion of her fins and tail keeping the eggs clean, which the fact of their being glued fast permits her to do without washing them away. The following incident will illustrate the necessity for this constant care and attention on the part of the female, as well as point a moral, and furnish an illustration of how the greatest possible increase of this fish may be brought about: One evening in the spring of 1886 I noticed a "jack light" coming down the river, and I felt certain that some of my pets would have to suffer. I had endeavored to protect them as much as possible by requesting such neighbors as I could reach to respect my wishes, and to avoid the beds that I had under observation. Nearly all were willing to do so, but this time one of them made a mistake, as I expected they might, and when I went out in the morning the mother fish was gone. I thought I would secure the young fish (they were just hatched) and take them to the house and "bring them up by hand." So, putting on my wading boots, I walked out to the bed, and there I found, not the young fry, but three or four crayfish and some minnows, which had evidently devoured every fish on the bed. At another time, under similar circumstances, except that the eggs were not hatched, the crayfish had destroyed all the eggs. I took up every pebble without finding a single one.

The eggs are hatched in from five to ten days, according to the temperature of the water. When first hatched, the young fish are transparent, and so small as to be invisible to the naked eye. They have a much larger umbilical sac than the young

brook trout, in proportion to the size of the body. At first they are unable to swim, or even move themselves from the bottom, but in from two to six weeks they begin to rise and swim, although they are from one to two months old before the sac wholly disappears and they become perfectly developed fish.

After the fish are hatched the mother seldom passes over the bed, as in their then helpless state the motion of her fins would scatter them; but instead she now swims in circles around it driving away all intruders, such as minnows, crawfish, etc. After the young begin to swim she enlarges the circle until it becomes from ten to fifteen feet in diameter, she then gradually drives them toward the shore into shallow water where she keeps them inside of a half circle, the shore forming the other side. From this half circle all of their natural enemies are carefully excluded, and the fish are allowed to develop. After that is done she scatters them along the shore among the weeds and grass, where, if pursued, they can find hiding places. Then, and only then, does she leave them to care for themselves. They are now from one-half to three-fourths of an inch in length, black in color and very lively, darting out of their hiding places and seizing their prey as readily as the older fish, and by the first of October following will be two inches in length.

I should estimate the average number of eggs in the beds at 4,000. Owing to the fact that some of the beds observed were near the mouths of cold spring brooks, where the temperature of the water in the river was much lower than where other beds were located, will account in a great measure, in my opinion, for the variation in the time taken for hatching the eggs and the development of the young fish; as in some seasons, and in some locations, I have found the young fish developed or weaned in one month from the time that the ova were deposited, and at other times two months were required for the same purpose.

I have been unable to procure both male and female fish at the proper time to try artificial impregnation, but have repeatedly taken part of the ova from the bed as soon as impregnated, and hatched them in dishes, and have kept them there until fully developed. I am of the opinion that very little can

be done in the way of artificial impregnation or hatching, as nature has done for the black bass all that could be done.

All that the fish-culturist needs to do is to stock all suitable waters with them, where they do not now exist, and then protect them during the spawning season.

Cascade, Mich.

MR. FRED MATHER announced that the reports of salmon captures in the Hudson were increasing and that the river has been proved to have all the conditions necessary for a good salmon river, except fishways to enable the fish to surmount the dams and natural obstacles between Troy and the spawning grounds. In 1880 he had suggested to Prof. Baird that it was possible that this river was not a salmon river because the present fish had been debarred from the spawning grounds by natural obstructions before the settlement of the country, and that the trout streams near its source afford all the facilities for rearing young salmon, and in 1882 Mr. Mather hatched and planted 225,000 Penobscot salmon in Warren County. Every year since that plantings of increased numbers have been made from the Long Island hatchery under his supervision. This spring 440,000 were planted in the tributaries of the Hudson, in Warren County, and 20,000 on Long Island. In 1886 there was recorded ten salmon from the Hudson; in 1887 the number increased to between fifty and sixty, while this year over two hundred have already been taken, ranging in weight from six to twenty pounds. He had no doubt but the largest number of salmon taken were not heard of, but "North river salmon" was now a frequent sign in New York markets. While it is unlawful to capture these fish in the Hudson by any means excepting with hook and line, the fact that the gill-netters who drift for shad take many which are drowned before they reach them renders the law inoperative. Just before he left New York, Mr. Blackford told him of a fisherman at Yonkers who caught one but did not know what it was; he cut it open and it "looked red and unwholesome," and he threw it away. Now the fisherman is daily reminded of his mistake by his friends who ask if he has any red or diseased fish.

On motion, the meeting adjourned until the next day, and the members inspected the whitefish hatchery of the Michigan Fishery Commission, in the city, and although the whitefish hatching was over for the season, found interest in the eggs of wall-eyed pike and yellow perch, then in the hatching jars, and in the trout and grayling in the aquaria.

SECOND DAY'S PROCEEDINGS.

The meeting was called to order at 10 A. M., and the following was read :

NOTES ON THE FOOD OF THE FISHES OF THE MISSISSIPPI VALLEY.

BY PROF. S. A. FORBES.

There is a kind of insect in the South, called the agricultural ant, which is extremely fond of the seeds of certain grasses growing there spontaneously among the many species which make the prairie sod. Naturally, the agricultural methods of this ant are of a very primitive sort, and even fall below those of the native Indian. Besides collecting, wherever it can find them, the fallen seeds of many grasses and other plants, and storing these in its burrows, it also clears completely an area from six to twelve feet wide around its nest, and here either sows or permits to grow only one or two of the common grasses of whose seeds it is especially fond, harvesting the product and storing it for future use. It has not learned to cultivate the soil, or to introduce exotic plants of larger yield and better quality than those native to the sod, but it has advanced so far as to destroy on a little tract the competitors of the plants which bear its favorite food, and thus secures a larger and more convenient supply than would grow spontaneously. I mention this little ant because its agriculture seems to me to illustrate very well the aquaculture practiced by mankind at the present time. As this little insect collects the seeds of weeds wherever

they happen to grow, so we fish the streams for whatever they happen to contain; and as it clears its little farm around its burrow, so we make our little fish ponds, seine out the worthless and destructive fishes, the snakes, frogs, and turtles, and throw the better species back to increase for our benefit. In two things our aquaculture is in advance of the agriculture of the ants,—we have successfully introduced two or three foreign species, and we have learned to take measures to maintain the fish supply wherever it has suffered from the effects of overpopulation. The first of these measures the ants have not thought of, and the second they probably do not need, because their numbers do not overrun their food supply. I believe it will pay us to inquire whether we can hope to get beyond this ant stage of aquaculture, and whether we may not learn to do at least as much to increase and improve the product of the waters of the country as the wild Indian did to cultivate the soil.

At present, four things are done, in general: First, we attempt to maintain or restore the relative numbers of our valuable aquatic animals—fish especially—defending the population of our waters against the evils growing out of civilized settlement. This is like trying to restore the native growth of trees and grasses to the surfaces deadened by travel and building, and by careless or unskillful usuage. Second, we try to increase the relative numbers of the most valuable of our native aquatic animals above the limit fixed originally by nature. This is as if we should collect and plant the nuts and acorns in the woods, and gather and sow abroad the seeds of the most valuable native grasses, in the hope that this artificial aid might enable our favorites to surpass their rivals. Third, we have aimed to introduce foreign with our native species in our natural waters. This is too much like sowing quantities of apple seeds and wheat and corn broadcast in the woods and on the prairies in the hope that if we use seed enough the plants we seek to introduce will crowd out the native vegetation. And, finally, we do, on a small scale, partly imitate actual agriculture by clearing or forming little patches of water here and there, and planting in them an exotic fish, protecting it from the competition of the native species. Here we approach the

agricultural practice of the native Indian, who partly cleared his little patches in the river bottoms and planted and harvested the exotic corn and bean and pumpkin.

But it will not do to push this parallel too far. There are some things possible in agriculture which the aquaculturist cannot do. We cannot plow and till our lakes and rivers as the farmer does the prairie sod, ruthlessly exterminating all the native forms of life in order to substitute other sorts more useful to him. And even where we clear a little lake or start a pond, stocking it with carp or croppie, we cannot keep out the frogs and bullheads by any artificial tillage, as the farmer can the weeds. We are compelled, in other words, to work for improvement in the midst of things as they are. Not being able to destroy the native population of our waters, we have to take it into account and then make our adjustments to it. And right here, it has long seemed to me, is where the work is most needed. If we cannot get rid of the natural order, we certainly need to understand it. If we cannot destroy the native population, but must live and work with and through it, we certainly ought to know what it is like and what we can do with it; what we can do in spite of it, and what we cannot do because of it. It is because I have worked out some parts of an answer to these questions that I have ventured to appear here to-day, in a society of fish-culturists. If fish-culture is merely the culture of fishes, then I can have little or nothing to say, because I never raised a fish in my life; but if a scientific and rational fish-culture must finally merge in the broader science and art of aquaculture; if we must study to understand and improve the system of aquatic life into the midst of which we thrust our little fishes,—then I may perhaps claim some share in your deliberations.

What I have to report to-day is chiefly an answer to the question: What do our native fishes eat? This is only a single item of what we really need to know, and yet perhaps a larger one than might at first be supposed. Although fishes are the dominant class in every fairly permanent body of fresh water, they have no great variety of interests or occupations; but except for the relatively brief intervals devoted to their simple

office of reproduction, they do little but to search for food and to eat, and avoid being eaten in turn; consequently, if we seek to measure or estimate their function in the general system of life in any region or locality, we are limited chiefly to their food relations, immediate and remote.

Among the purely practical results to be anticipated from such a study, are a more accurate knowledge of the conditions favorable to the growth and multiplication of the more important species; the ability to judge intelligently of the fitness of any body of water to sustain a greater number or a more profitable assemblage of fishes than those occurring there spontaneously; guidance as to the new elements of food and circumstance which it will be necessary to supply to insure the successful introduction into any lake or stream of a fish not native there; and a clear recognition of the fact that intelligent fish-culture must take into account the necessities of the species whose increase is desired, through all ages and all stages of their growth, at every season of the year, and under all varieties of condition likely to arise.

We should derive, in short, from these and similar researches, a body of full, precise, and significant knowledge to take the place of the guess-work and empiricism upon which we must otherwise depend as the basis of our efforts to maintain and increase the supply of food and the incitement to healthful recreation afforded by the waters of the country.

As a contribution to the general subject, I present herewith a summary account of the food of twelve hundred and fifteen fishes, obtained from the waters of the State of Illinois at intervals from 1876 to 1887, and in various months from April to November. These fishes belonged to eighty-seven species of sixty-three genera and twenty-five families. They were taken from waters of every description, ranging from Lake Michigan to weedy stagnant ponds and temporary pools, and from the Mississippi and Ohio rivers to the muddy prairie creeks, and the rocky rivulets of the hilly portions of the State. Nine hundred and fourteen of the examples studied were practically adult, so far as the purposes of this investigation are concerned, the remaining three hundred and one being young, in

the first stage of their food and feeding habits. More than half these young belonged to a single species—the common lake whitefish—but the remainder were well distributed.

I have arranged the matter under the following general heads: (1) a general account of the food of the most important species and families of our native adult fishes; (2) a brief account of the food of the young; and (3) a summary statement of the food, so made as to exhibit (*a*) the kinds and relative importance of the principal competitions among fishes, and (*b*) the relative value to the principal species of fishes of the major elements of their food.

First, then, I will attempt to give you very briefly, and in the most general way, the facts relating to the food of the most important fishes, those which I think most likely to interest you as fish-culturists, taking the species in their zoölogical order rather than in the order of their economic importance.

FOOD OF ADULTS.

The abundant *white perch* or *sheepshead* of the larger rivers and lakes, now commonly marketed, I find feeding, when full grown, almost exclusively upon the bivalve mollusks known in the West as clams, whose heavy shells this fish is enabled to crush and grind by a special apparatus in the throat. The shells are swallowed with the bodies and pass, in part at least, through the intestine. Half-grown specimens feed in much larger ratio upon aquatic insects, especially the larvæ of May flies, but take likewise the smaller mollusks with spiral shells, commonly known as water snails, the food in my examples being about equally divided between these two elements. The youngest specimens feed, like the young of fishes in general, upon the smallest of the Crustacea.

The *common perch* or "*ring perch*," excessively abundant throughout the northern part of the country, varies in food according to the waters it inhabits, those in the great lakes feeding almost wholly upon small fishes (especially of the minnow family), and upon crayfishes—five or six times as many of the former as of the latter. River specimens, however, eat few fishes, but find nearly half their food among the Crustacea,

partly crayfishes, but chiefly the smaller kinds, known to zoölogists as amphipods and isopods, and in common speech as water wood-lice and brook shrimps. Aquatic insect larvæ, especially those of day-flies, and small spiral-shelled mollusks are eaten in about equal ratio.

The two *pike-perch* or "*wall-eyed pike*," are exclusively piscivorous, if we may judge from twenty-six specimens whose food I studied. More than a fourth of the fishes taken consisted of the spiny-finned species, including eight per cent. of catfishes, but nearly half were the common gizzard shad.

We shall find accumulating evidence that this shad, not used with us for food, is, notwithstanding, one of the most valuable fishes in our streams. Nevertheless, not the slightest attention is paid to its preservation, much less to its encouragement. The fishermen commonly regard these fishes as a mere nuisance, and leave them to die on the bank by hundreds, rather than take the trouble to return them to the water. They are a very delicate species, and are easily killed by rough handling in the seine, but the majority of those captured might be saved with a little care.

Their abundance as compared with some other species in our rivers might seem to indicate that they are common enough as it is. Few realize, however, the number of fishes needed to feed a pike-perch to maturity. Two or three items from my notes will furnish the basis for an intelligent estimate.

From the stomach of a pike-perch caught in Peoria Lake, October 27, 1878, I took ten well-preserved specimens of gizzard shad, each from three to four inches long; and from another I took seven of the same species, none under four inches in length. As the gizzard shad is a very thin, high fish, with a serrate belly, these were as large as a pike-perch can well swallow; and we may safely suppose that not less than five of this shad would make a full meal for that fish. The pike-perch is a very active hunter, and it is not at all probable that one can live and thrive on less than three such meals a week. The specimens above mentioned were taken in cold autumn weather, when most other fishes were eating but little; but since fishes generally take relatively little food in winter, we will suppose that

the pike-perch eats, during the year, on an average, at this rate per week for forty weeks, giving us a total *per annum* of six hundred gizzard shad destroyed by one pike-perch. We cannot reckon the average life of a pike-perch at less than three years, and it is probably nearer five. The smallest estimate we can reasonably make of the food of each pike-perch would therefore be somewhere between eighteen hundred and three thousand fishes like the gizzard shad. A hundred pike-perch, such as should be taken each year along a few miles of a river like the Illinois, would therefore require from one hundred and eighty thousand to three hundred thousand fishes for their food. Finally, when we take into account the fact that a number of other species also prey upon the gizzard shad, and that the whole number destroyed in all ways must not exceed the mere *surplus* reproduced—otherwise the species would soon be extinguished—we can form an approximate idea of the multitudes in which the food species must abound if we would support any great number of predaceous fishes. The gizzard shad, being a mud-eater and a vegetarian, taking little animal food except when very young, can probably be more readily maintained in large numbers in our muddy streams than any other fish.

The two species of *black bass* differ, according to my observations, in the character of their food, the large-mouthed species eating more fishes, and the small-mouthed more crayfishes. Here, also, the gizzard shad made more than half the food.

The *common sunfishes* are readily divisible into four groups, based on their feeding structures and their food ; one characterized especially by the wide mouth, including the black warrior and the blue-cheeked sunfish, took a noticeable amount of fishes, the ratio varying from a third to a half, the remainder of the food being chiefly insects, crayfishes, and smaller crustaceans. Those with small mouths, pointed teeth in the throat, and short gill-rakers, like the most abundant of the river species, took scarcely any fishes, but fed chiefly on insects and crustaceans, the latter principally the forms of medium size (amphipods and isopods). Some of this group

likewise took a large amount of vegetation, amounting to a third or fourth of the whole.

A group with small mouths, and blunt conical teeth in the throat, illustrated by the common bream or pumpkin seed, was distinguished especially by the number of small snail-like mollusks eaten, these making, in my specimens, more than a third of the food. The remainder was chiefly aquatic insect larvæ, the medium-sized Crustacea, and water plants.

The fourth group, illustrated by the croppies, have the mouth long but narrow, and the gill-rakers numerous and long. By these a few fishes are taken, but the food is chiefly insects and the smallest crustaceans—those commonly referred to as Entomostraca, a food resource which they are enabled to draw upon by the straining apparatus in the gills.

Passing to the pike or pickerel of our western rivers, I find that the common large *river pike*, *Esox lucius*, is almost wholly piscivorous, a single specimen only out of the thirty-seven examined, having taken a number of dragon flies. About a fifth of the fishes were sunfishes (half of them croppies) and black bass. Twenty of these thirty-seven pike had taken gizzard shad, which made, in fact, nearly half of the food of the entire group. Minnows were found in only two, and three had eaten buffalo fish.

The striking features of this record are the importance of the gizzard shad, the abundance of the spiny-finned fishes, including some of the most valuable kinds, and the insignificant number of minnows and suckers taken.

The "*grass pickerel*," a species which rarely reaches a foot in length, had eaten tadpoles of frogs, and fishes, and insects, the latter making more than a third of the food, and consisting chiefly of larvæ of dragon flies.

The *gizzard shad*, mentioned above as an especially valuable element of the food of the higher fishes, feeds itself almost wholly upon mud, with which the long and coiled intestine of every specimen was filled from end to end. This mud contained, on an average, about twenty per cent. of minute vegetable *débris*, with occasionally a little animal matter.

The great *minnow family* I can scarcely pass by, since it

contributes so largely to the food of other fishes, although itself of little or no direct advantage to mankind. I found this family dividing into several groups based upon the length of the intestine and the form of the pharyngeal teeth. In the first of these groups, containing several of the more abundant sorts, about three fourths of the food consisted of soft black mud, the remainder being both animal and vegetable matter, chiefly the latter. These fishes all had very long intestines and smooth grinding teeth in the throat. In another group quantities of mud are also taken, but with it many Entomostraca; while in groups three and four, containing by far the greater portion of the family, the food is essentially different, about three fourths of it being insects and small crustaceans, and the remainder vegetation. I note especially here the value of the mud-eating minnows as food for larger fishes, since while abundant and easily maintained, they do not compete with the young of the larger fishes to whose sustenance they may be applied.

One of the most striking characteristics of the fish-fauna of the Mississippi Valley is the prominence of the *sucker family*, several of which are among the most abundant of our larger fishes. About one tenth the food of this family taken as a whole consisted of vegetation, eaten chiefly by the buffalo fishes, and in them composed largely of distillery slops. The family is, however, essentially carnivorous, mollusks and insects appearing in nearly equal ratio in the food. The former are taken much the more generally by the cylindrical suckers, and the latter about equally by all except the stone roller, which collects great quantities of insect food by pushing about the stones in running water. A large proportion of the insects eaten are small larvæ of gnats (Chironomus). Some of the deeper-bodied species with long gill-rakers, especially the river carp, feed largely on Entomostraca, this latter species swallowing also considerable quantities of mud.

The *catfishes*, taken together, are nearly omnivorous in habit, and their feeding structures have a correspondingly general character. The capacious mouth, wide gullet, and short, broad stomach admit objects of large size and nearly every shape. The jaws, each armed with a broad pad of fine, sharp teeth, are

well calculated to grasp and hold soft bodies as well as hard. The gill-rakers are of average number and development, and crushing jaws in the throat, broad, stout arches below, and oval pads above, covered with minute pointed teeth, serve fairly well to break the crusts of insects and the shells of the smaller mollusks, and to squeeze and grind the vegetable objects which occur in the food. The most peculiar feeding habit relates to the larger bivalve mollusks, the bodies of which are frequently found almost entire in the stomachs of these fishes and always without a fragment of a shell. I have been repeatedly assured by fishermen that the catfish seizes the foot of the mollusk while the latter is extended from the shell, and tears the animal loose by vigorously jerking and rubbing it about. One intelligent fisherman informed me that he was often first notified of the presence of catfishes in his seine, in making a haul, by seeing the fragments of clams floating on the surface, disgorged by the struggling captives. Finally, these are the only habitual scavengers among our common fishes. The larger deep-water species from the great rivers are strictly piscivorous, so far as known. Very small stone-cats feed on the smaller insect larvæ and the medium-sized crustacea. The spotted cat, blue Fulton, or fiddler, feeds largely on mollusks, but is, nevertheless, chiefly insectivorous. It differs from most of the river catfishes by eating water-plants to a considerable extent. The common bullhead is more strictly omnivorous than any other kind, its food being composed about equally of fishes, mollusks, aquatic insects, and vegetable structures, with a very considerable ratio of crustaceans added. The great mud-cat or Morgan cat, reaching a weight of over one hundred pounds, seems to feed entirely upon fishes.

The abundant and peculiar *dogfish*, or "*grindle*," is strictly carnivorous, about one third of the food being fishes, a fourth of it small mollusks, and nearly half crustaceans, chiefly crayfish.

The *gárs* are all strictly piscivorous, feeding especially upon the gizzard shad.

The most remarkable of our fishes, in structure and feeding habit, is the *shovel-fish*, or "*spoonbill*," of the Mississippi and

its larger tributaries. It is a large species, reaching a weight of thirty pounds and upwards and a length of six feet or more, including the paddle-like snout. Although so large, the greater part of its food consists of the smallest aquatic Crustacea and insect larvæ, strained from the water by means of an extraordinary apparatus in the gills, composed of long and slender gill-rakers, a double series on each arch, and over five hundred in a series. Interlocking as these do when the gill apparatus is extended, they form a strainer sufficient to arrest the smallest living forms above the Protozoa, and with the immense opening of the mouth and equally free provision for the exit of water from the gill chamber, enable this fish to strain out enormous quantities of these minute animal forms, especially those most commonly reserved for young fishes. It takes also, in midsummer, insect larvæ of medium size, but evidently avoids vegetation, and never swallows mud.

FOOD OF THE YOUNG.

By an examination of three hundred and one specimens, representing twenty-seven species, twenty-six genera, and twelve families of Illinois fishes, I learn that the food of many species of fishes differs greatly according to age; and that, in fact, the life of most of our fishes divides into at least two periods, and that of many into three, with respect to the kinds of food chiefly taken. Further, in the first of these periods a remarkable similarity of food was noticed among species whose later feeding habits are widely different. The full-grown black bass, for example, feeds principally on fishes and crayfishes, the sheepshead on mollusks, and the gizzard shad on mud and Algæ, while the catfishes are nearly omnivorous; yet all these agree so closely in food when very small, that one could not possibly tell from the contents of the stomachs which group he was dealing with.

In the earliest stage, all the fishes studied, except suckers and minnows, depend for food on the smallest crustaceans, commonly called Entomostraca, and on certain small worm-like larvæ of gnats or gnat-like flies scarcely larger than these crustaceans, and usually occurring with them. By far the most

abundant of these insect larvæ was that known as Chironomus. The suckers and minnows differ from our other fishes by being toothless while very young, as well as when adult, while our other toothless fishes, gizzard shad, whitefish, etc., have in youth a set of evanescent teeth. These toothless young I found feeding in part on still smaller prey than the others, taking the smallest animal forms (wheel animalcules), various Protozoa, and Algæ so minute that the whole plant consists of a single vegetable cell. The food of the whitefish fry was determined by keeping several hundred of them in a large aquarium kept constantly supplied with all the living objects which a fine gauze net would separate from the waters of Lake Michigan.*

While small fishes of all sorts are evidently competitors for food, this competition is relieved to some extent by differences of breeding season, the species dropping in successively to the banquet, some commencing in very early spring, or even, like the whitefish, depositing their eggs in fall, that their young may be the first at the board, while others delay until June or July. The most active breeding period coincides, however, with that of the greatest evolution of Entomostraca in the backwaters of our streams; that is, the early spring. That large adult fishes with fine and numerous rakers on the gills—like the shovel fish and the river carp—may compete directly with the young of all other species, and tend to keep their numbers down by diminishing their food supply—especially in times of scarcity—is very probable, but is not certainly true as a general thing; for these larger fishes have other food resources, also, and may resort to Entomostraca only when these are superabundant, thus appropriating the mere excess above what are required for the young of other groups. Of the fishes which emerge from this earliest stage through increase in size with failure to develop alimentary structures especially fitted to the appropriation of minute animal forms, some become mud-eaters, like the Campostoma and the gizzard shad; a few apparently become vegetarians at once; but most pass into or through an insectivorous stage. After this a few become nearly omnivorous,

* See note following this paper.

like the bullheads; others learn to depend chiefly on molluscan food—the sheepshead and the red horse species; but many become essentially carnivorous. In fact, unless the gars are an exception, as they now seem to be (attacking young fishes almost as soon as they can swallow), all our specially carnivorous fishes make a progress of three steps, marked, respectively, by the predominance of Entomostraca, insects, and fishes in their food; and the same is true of those strictly fitted for a molluscan diet.

PRINCIPAL ELEMENTS OF THE FOOD.

An analysis of the facts made with reference to the kinds of fishes eating each of the principal articles in the dietary of the class, and showing the relative importance of these elements in the food of the various species, will have its separate interest for us, especially as it will exhibit the competitions of fishes for food, and also the nature and the energy of the restraints imposed by fishes on the multiplication of their principal food species.

The principal *fish-eaters* among our fishes—those whose average food in the adult stage consists of seventy-five per cent., or more, of fishes—are the burbot, the pike-perch or wall-eyed pike, the common pike or pickerel, the large-mouthed black bass, the channel-cat, the mud-cat, and the gars. Possibly, also, the golden shad will be found strictly ichthyophagous, this being the case with the four specimens which I studied. Those which take fishes in considerable but moderate amount—the ratios ranging in my specimens from twenty-five to sixty-five per cent.—are the war-mouth (Chænobryttus), the blue-cheeked sunfish, the grass pickerel, the dog-fish, the spotted cat, and the small miller's thumb. The white and the striped bass, the common perch, the remaining sunfishes (those with smaller mouths), the rock bass, and the croppie, take but few fishes, these making, according to my observations, not less than five nor more than twenty-five per cent. of their food. Those which never capture living fishes, or, at most, to a merely trivial extent, are the white perch or sheepshead, the gizzard shad, the suckers, and the shovel fish

among the larger species ; and the darters, the brook silversides, the stickleback, the mud minnows, the top minnows, the stonecats, and the common minnows generally, among the smaller kinds. Our eight specimens of the toothed herring had taken no fishes whatever ; while our nineteen examples of the pirate perch had eaten only two per cent.

Rough-scaled fishes with spiny fins were eaten by the miller's thumb, the common pike, the wall-eyed pike, the large-mouthed black bass, the croppies, the dog-fish, the common perch, the burbot, the bull-head, the common sunfish (*Lepomis pallidus*), the small-mouthed black bass, the grass pickerel, the gar, and the mud-cat (Leptops). Among these, the common perch and the sunfishes were most frequently taken—doubtless owing to their greater relative abundance—the perch occurring in the food of the burbot, the large-mouthed black bass, and the bullhead ; and the sunfishes in both species of wall-eyed pike, the common pike, the gars, pickerel, bullheads, and mud-cat. Black bass were taken from the common pike (Esox), the wall-eyed pike (Stizostedion), and the gar. Croppie and rock bass I recognized only in the pike. Even the catfishes with their stout, sharp, and poisoned spines were more frequently eaten than would have been expected—taken, according to my notes, by the wall-eyed pike, both black bass, and a fellow species of the family, the *goujon* or mud-cat.

The soft-finned fishes were not very much more abundant, on the whole, in the stomachs of other species, than those with ctenoid scales, spiny fins, and other defensive structures, an unexpected circumstance which I cannot at present explain, because I do not not know whether it expresses a normal and fixed relation, or whether it may not be due to human interference.

Only the catfishes seem to have acquired defensive structures equal to their protection, the predatory apparatus of the carnivorous fishes having otherwise outrun in development the protective armor of the best-defended species.

Among the soft-finned species the most valuable as food for other fishes is the gizzard shad, Dorosoma, this single fish being about twice as common in adults as all the minnow family taken

together. It made forty per cent. of the food of the wall-eyed pike ; a third that of the black bass ; nearly half that of the common pike or "pickerel" ; two thirds that of the four specimens of golden shad examined ; and a third of the food of the gars. The only other fishes in whose stomachs it was recognized were the yellow cat, *Ictalurus natalis*, and young white bass, Roccus. It thus seems to be the especial food of the large game fishes and other particularly predaceous kinds.

The minnow family (Cyprinidæ) are in our waters especially appropriated to the support of the half-grown game fishes, and the smaller carnivorous kinds. They were found in the wall-eyed pike, the perch, the black bass, the blue-cheeked sunfish, the croppie, the pirate perch, the pike, the little pickerel, the chub minnow, the yellow cat, the mud-cat, the dog-fish, and the gar.

Suckers, Catostomatidæ, I determined only from the pike, the sheepshead, the blue-cheeked sunfish (*cyanellus*), the yellow cat, and the dog-fish (*Amia*). Buffalo and carp occurred in the pike, the dog-fish, and the above sunfish.

The ponds and muddy streams of the Mississippi Valley are the native home of *mollusks* of remarkable variety and number, and these form a feature of the fauna of the region not less conspicuous and important than its leading groups of fishes. We might, therefore, reasonably expect to find these dominant groups connected by the food relation ; and consistently with this expectation, we observe that the sheepshead, the catfishes, the suckers, and the dog-fish find an important part of their food in the molluscan forms abundant in the waters which they themselves most frequent. The class as a whole makes about one fourth of the food of the dog-fish and the sheepshead—taking the latter as they come, half-grown and adults together—about half that of the cylindrical suckers—rising to sixty per cent. in the red horse—and a considerable ratio (fourteen to sixteen per cent.) of the food of the perch, the common catfishes (Amiurus and Ictalurus), the small-mouthed sunfishes, the top minnows, and the shiner (Notemigonus). Notwithstanding the abundance of the fresh-water clams or river mussels (Unio and Anodonta), only a single river fish is especially adapted to their destruction, viz., the white perch or sheeps-

head, and this species derives, on the whole, a larger part of its food from univalve than from bivalve mollusks, the former eaten especially by half-grown specimens, and the latter being the chief dependence of the adults. The ability of the catfishes to tear the less powerful clams from their shells has been already mentioned. Large clams were eaten freely by the full-grown sheepshead—whose enormous and powerful pharyngeal jaws with their solid pavement teeth are especially adapted to crushing the shells of mollusks—and by the bull-heads (Amiurus), especially the marbled cat. The small and thin-shelled Sphæriums are much more frequent objects in the food of mollusk-eating fishes than are the Unios. This genus alone made twenty-nine per cent. of the food of our one hundred and seven specimens of the sucker family, and nineteen per cent. of that of a dozen dog-fishes. Among the suckers it was eaten greedily by both the cylindrical and the deep-bodied species, although somewhat more freely by the former. Even the river carp, with its weak pharyngeal jaws and delicate teeth, finds these sufficient to crush the shells of Sphærium, and our nineteen specimens had obtained about one fourth of their food from this genus. Besides the above families, smaller quantities of the bivalve mollusks occurred in the food of one of the sunfishes (*Lepomis pallidus*), and—doubtless by accident only—in the gizzard shad. The gasteropod mollusks (snails of various descriptions) were more abundant than bivalve forms in the sheepshead, sunfish, and all the smaller fishes which feed upon Mollusca, but less abundant in the suckers and the catfishes. In the sheepshead they made one fifth of the food of the twenty-five specimens examined, but the greater part of these had not yet passed the insectivorous stage, this being much longer continued in the sheepshead than in many other fishes. A few of these univalve Mollusca occurred in the food of the common perch and in certain species of sunfishes—especially the superabundant bream or pumpkin-seed. They made fifteen per cent. of the food of the minute top minnows, and occurred in smaller quantities among the darters, the little pickerel, the mud minnows and the cyprinoids. The heavier river snails, Vivipara and Melantho, were eaten especially by the cylindrical suckers and

the catfishes. The delicate pond snails (Succinea, Lemna, and Physa) were taken chiefly by the smaller mollusk-eating fishes—a few of them also by the catfishes and the suckers.

It is from the class of *insects* that adult fishes derive the most important portion of their food; and, taken as a whole, this class furnishes thirty-eight per cent. of the food of all which I examined. The principal insectivorous fishes are the smaller species, whose size and food structures, when adult, unfit them for the capture of Entomostraca and yet do not bring them within reach of fishes or Mollusca. Some of these fishes have peculiar habits which render them especially dependent upon insect life—the little minnow, Phenacobius, for example, which, according to my studies, makes nearly all its food (ninety-eight per cent.) from insects found under stones in running water. Next are the pirate perch, Aphredoderus (ninety-one per cent.), then the darters (eighty-seven per cent.), the croppies (seventy-three per cent.), half-grown sheepshead (seventy-one per cent.), the shovel fish (fifty-nine per cent.), the chub minnow, Semotilus (fifty-six per cent.), the black warrior sunfish (Chænobryttus) and the brook silversides (each fifty-four per cent.), and the rock bass and the cyprinoid genus Notropis (each fifty-two per cent).

Those which take few insects or none are mostly the mud feeders and the ichthyophagous species, Amia (the dog-fish) being the only exception to this general statement. Thus we find insects wholly or nearly absent from the adult dietary of the burbot, the pike, the gar, the black bass, the wall-eyed pike, and the great river catfish, and from that of the hickory shad and the mud-eating minnows (the shiner, the fat-head, etc.). It is to be remembered, however, that the larger fishes all go through an insectivorous stage, whether their food when adult be almost wholly other fishes, as with the gar and the pike, or mollusks, as with the sheepshead. The mud-feeders, however, seem not to pass through this stage, but to adopt the limophagous habit as soon as they cease to depend upon Entomostraca.

Terrestrial insects, dropping into the water accidentally or swept in by rains, are evidently diligently sought and largely

depended upon by several species, such as the pirate perch, the brook minnow, the top minnows or killifishes (Cyprinodonticlæ), the toothed herring and several cyprinoids (Semotilus, Pimephales, and Notropis).

Among aquatic insects, minute, slender dipterous larvæ are of remarkable importance, making, in fact, nearly one twelfth of the food of all the fishes studied. They amounted to about one third the food in fishes as large and important as the red horse and the river carp, and made nearly one fourth that of fifty-one buffalo fishes. They appear further in considerable quantity in the food of a number of the minnow family (Notropis, Pimephales, etc.), which habitually frequent the swift water of stony streams. Aquatic beetles and larvæ, notwithstanding the abundance of some of the forms, occurred in only insignificant ratios, but were taken by fifty-six specimens. The adult surface beetles, whose zig-zag darting swarms no one can have failed to notice, were not once encountered in my studies.

The almost equally well-known slender water-skippers seem also completely protected by their habits and activity from capture by fishes, only one occurring in the food of all our specimens.

It is from the order Neuroptera that fishes draw a larger part of their food than from any other single insect group. In fact, nearly one sixth of the entire amount of food consumed by all the fishes examined by me consisted of aquatic larvæ of this order, the greater part of them larvæ of day flies. These Neuroptera larvæ were eaten especially by the miller's thumbs, the sheepshead, the white and striped bass, the common perch, thirteen species of the darters, both the black bass, seven of the sunfishes, the rock bass and the croppies, the pirate perch, the brook silversides, the sticklebacks, the mud minnow, three top minnows, the gizzard shad, the toothed herring, twelve species each of the true minnow family and of the suckers and buffalo, five catfishes, the dog-fish and the shovel-fish—seventy species out of the eighty-seven which I studied.

Of the four principal classes of the food of fishes, viz., fishes, mollusks, insects, and *Crustacea*, the latter stand third in importance according to my observations, mollusks alone being

inferior to them. That insect larvæ should be more abundant in the food of fresh-water fishes than are crustaceans, is a somewhat unexpected fact, but while the former make about twenty-five per cent. of the food of our entire collection, the crustaceans amount to only fourteen per cent. Crayfishes made about a sixth of the food of the burbot, about a tenth that of the common perch, a fourth that of half a dozen gars, and not far from a third that of the black bass*, the dog-fish, and our four rock bass. Young crayfishes appeared quite frequently in some of the larger minnows (Semotilus and Hybopsis), and also in catfishes, especially the pond and river bull-heads, averaging nearly fifteen per cent. of the entire food of the two most abundant species.

The minute crustaceans commonly grouped as Entomostraca are a much more important element. Among full-grown fishes, I find them especially important in the shovel-fish—where they made two thirds of the food of the specimens studied—and in the common lake herring. Among the sunfishes at large they were present in only insignificant ratio; but the croppies, distinguished by long and numerous rakers on the anterior gill, had derived about a tenth of their food from these minute crustaceans. In the early spring, especially, when the backwaters of the streams are filled with Entomostraca, the stomachs of these fishes are often distended with the commonest forms. Ten per cent. of the food of the sucker family consisted of them, mostly taken by the deep-bodied species, in which they made a fourth or a fifth of the entire food. This fact is explained, it will be remembered, by the relatively long, slender, and numerous gill-rakers of these fishes. Large river buffalo were occasionally crammed with the smallest of these Entomostraca, only a twenty-fifth of an inch in length.

I have several times remarked the peculiar importance of Entomostraca to the shovel-fish—one of the largest of our fresh-water animals—a fact accounted for by the remarkable branchial strainer of this species, probably the most efficient apparatus of its kind known to the ichthyologist. Here, again, the smallest forms were the most abundant.

* Our specimens—especially of the small-mouthed black bass—were too few in number to make this average reliable.

Probably to those accustomed to the abundance of true *worms* in marine situations, no feature of the poverty of fresh-water life will be more striking than the small number of this subkingdom occurring in the course of miscellaneous aquatic collections in the interior. Similarly, we notice that in the food of fishes the occurrence of Vermes is so rarely noticed that they might be left out of account entirely without appreciably affecting any of the important ratios. Catfishes alone seem purposely to eat leeches, these occurring in nine specimens of three different species of this family, and also in one common sucker and in a single shovel-fish. One of the fresh-water *Sponges* (Spongilla) had been eaten in considerable quantities by two examples of the spotted cat taken in September, but this element was not encountered elsewhere in my studies.

That the minutest and simplest of all the animal forms, far too small for the eye of a fish to see without a microscope, should have been recognized in the food of seventeen species of fishes is, of course, to be explained only as an incident of the feeding habit. It is possible, however, that these *Protozoa*, where especially abundant, may be recognized in the mass by the delicate sensory structures of the fish; and they seem in most cases to have been taken with mud and slime, rich in organic substances. As most of them are extremely perishable, and can scarcely leave a trace a few seconds after immersion in the gastric juices of the fish, it is probable that they contribute much more generally than our observations indicate to the food of some fishes, especially to those which feed upon the bottom.

Young suckers under six inches in length clearly take them purposely, substituting them in great part for the Entomostraca taken by other fishes of their size and age.

I detected Protozoa in the food of several genera of Cyprinidæ, in the young of buffalo, the river carp, the chub sucker, the red-horse, the stone roller, in the common sucker, in a single gizzard shad, in a stone-cat, and in a top minnow.

The only *scavenger* fishes of our collection were three species of the common catfishes; the spotted cat, the yellow cat, and the marbled cat—all of which had eaten dead animal matter, including pieces of fish, ham, mice, kittens, and the like. A single

large-mouthed black bass had likewise eaten food of this description.

Considering the wealth of *vegetation* accessible to aquatic animals, and the fact that few other strictly aquatic kinds have the vegetarian habit, it is indeed remarkable that fishes draw from plants an unimportant part of their diet. Taking our nine hundred specimens together, the vegetation eaten by them certainly would have amounted to less than ten per cent. of their entire food, and excluding vegetable objects apparently taken by chance, it probably would not reach five per cent.

The greatest vegetarians are among the minnow family. Counting each genus as a unit, I find that the family as a whole obtained from plants about twenty-three per cent. of its food. The little Phenacobius, already reported as strictly insectivorous, was the only one studied in which vegetation can scarcely be said to occur.

Certain of the sunfishes evidently take plant food purposely on occasion, this making, for example, nearly a tenth of the food of forty-seven specimens of Lepomis. Among the larger fishes, the principal vegetarians are the gizzard shad, in which this element was reckoned at about a third, taken, however, not separately, but with quantities of mud. A considerable part of the vegetation here included, consisted of distillery slops obtained near towns. The buffalo fishes are likewise largely vegetarians, more than a fourth of their food coming from the vegetable kingdom; about a third of this in our specimens being refuse from distilleries. Vegetation made a tenth of the food of the larger genera of catfishes (Amiurus and Ictalurus)—some of it distillery refuse—and nearly as large a ratio of the great Polyodon.

Not infrequently, terrestrial vegetable rubbish—seeds of grasses, leaves of plants, and similar matter—was taken in quantity to make it certain that its appropriation was not accidental. The principal *mud-eating* fishes are the gizzard shad, the common shiner, and certain genera of minnows with elongate intestines and cultrate pharyngeal teeth. Much mud was also taken by the cylindrical members of the sucker family, but apparently as an incident to their search for mollusks.

CONCLUSION.

I cannot attempt to discuss the practical bearing of the mass of data here presented, or of the much greater number which I have withheld, partly because the time is lacking, and partly because I know too little of practical fish-culture ; and I will merely call attention to a few illustrative points which have occurred to me in writing.

It would seem that the fact that all young fishes compete, at first, for food must have important practical results tending in various directions. It is probable that all fishes which are not especially adapted to the food requirements of the more valuable fishes are hurtful to them, because they limit the food available for their young. It seems possible that even the food species of the predaceous fishes may multiply to an extent injurious to the latter, since both robber and prey compete while young for the same elements of food. It would seem entirely likely that large fishes, like the shovel-fish, which destroy when adult immense quantities of the proper food of the young, must be reckoned as injurious.

Again, it is evident that the fishes most desirable as food for other kinds are those whose own food is not eaten by valuable species, but exists in practically inexhaustible supplies. The gizzard shad and the mud-feeding minnows are examples of this sort; while the red-horse and other cylindrical suckers answer the purpose almost equally well, since no valuable fishes feed upon mollusks (especially preferred by the suckers), and these are among the most abundant animals in our western streams. The fact that they have likewise adapted themselves to civilization, so far at least as to relish distillery slops, is, perhaps, an additional recommendation from this point of view.

The smaller catfishes, being practically omnivorous, are the rivals of every other kind ; and being almost perfectly protected from capture by their stout, sharp, poisoned spines, they contribute little to the food supply of other fishes. The common sunfishes are almost equally worthless and injurious from this point of view.

I need scarcely say that the fish-culturist should examine the waters in which young fishes are planted, in order to determine the amount of their appropriate food available. It is not impossible that myriads of whitefish have been set free to perish by starvation before the feeble fry could disperse widely enough to secure a single meal. It seems to me also, that in every case where it is proposed to introduce a new fish into waters already populated, the first question to be asked should be, what fishes do these waters already contain—and in what numbers—whose food and whose relations to nature generally are substantially the same as those it is intended to introduce?

And, finally, I would call attention to the necessity of keeping continuous watch of the balance and abundance of plant and animal life in its various leading forms in any body of water in which it is thought desirable to maintain especial kinds of fishes in the greatest number possible. The owner of a fish pond especially, who makes himself acquainted with the entire collection of animals and plants which his pond contains, and keeps the run of these in their variations of number and habit, from season to season and from year to year, will not only get some practical hints thereby, which will aid him in the multiplication and preservation of his fish, but will derive no small amount of pleasure from his observations, and from the reasonings and reflections to which they will give rise.

NOTE ON THE FIRST FOOD OF THE WHITEFISH.

An elaborate account of this research was published in 1883, in the first volume of the Bulletin of the Illinois State Laboratory of Natural History; but as this article was not widely distributed among fish-culturists, the great practical importance of the subject, will perhaps, justify the following extracts from it: More light was thrown upon the earliest food habits of these fishes by the discovery of raptatorial teeth upon the lower jaw, than by the dissections of their alimentary canals. All the families of fishes which I had previously studied whose young were provided with teeth, were found strictly dependent at first upon Entomostraca and the minuter insect larvæ; while

only those whose young were toothless fed to any considerable extent upon other forms. The discovery of teeth in the young whitefish, therefore, placed this species definitely in the group of those carnivorous when young. The fact that the adult was itself toothless interfered in no way with this inference, because other toothless fishes (Dorosoma) whose young were furnished with teeth, had been found carnivorous at an early age.

The inconclusive character of the results thus far obtained, made it necessary to attempt to imitate more closely the natural conditions of the young when hatched in the lake. In February, 1881, I obtained, through the kindness of Mr. Clarke, twenty-five specimens of living young whitefish, saved from a lot which he was planting in the waters of Lake Michigan, off Racine, Wisconsin. I succeeded in conveying them to the laboratory without loss, and there kept them for several days in a glass aquarium and supplied them with an abundance of the living objects to be obtained by drawing a fine muslin net through the stagnant pools of the vicinity. These consisted of many diatoms and filamentous fresh-water Algæ, of two or three species of Cyclops, of *Canthocamptus illinoisensis*, and *Diaptomus sanguineus* among the Copepoda, and of two rather large Cladocera, *Simocephalus vetulus* and *S. americanus*. These little fishes were kept under careful observation for several days, the water in the aquarium being frequently aërated by pouring. Many of them had, however, been injured by handling, and eleven of the specimens died without taking food. It was soon evident that the larger Entomostraca (the *Simocephalus*, and even the *Diaptomus*) were quite beyond the size and strength of these little fishes, and that only the smaller Copepoda, among the animals available, could afford them any food at first. These they followed about from the beginning with signs of peculiar interest, occasionally making irresolute attempts to capture them. Two days after their arrival, one of the young whitefish had evidently taken food, which proved, on dissection, to be a small Cyclops. During the next two days nine others began to eat, dividing their attentions between the Cyclops above mentioned and the Canthocamptus, and on the 22d two other took a Cyclops each and a third a Canthocamptus.

One of these fishes contained still a large remnant of the egg-sac, showing that the propensity to capture prey must antedate the sensation of hunger. On the 25th the fourteenth and last remaining fish captured its Cyclops, and was itself sacrificed in turn. As an indication of the efficiency of the raptatorial teeth, it may be worth while to note that I saw one of the smallest fishes make a spring at a Cyclops, catch it, give three or four violent wriggles, and drop it dead to the bottom of the tank.

As a general statement of the result of the observations made on these fourteen fishes, we may say that eight of them ate a single Cyclops each, that one took two, and another three of the same, that one took a single Canthocamptus, that two specimens captured two each of this genus, and that finally, a single fish ate Cyclops and Canthocamptus both. The final conclusion was a highly probable inference that the smallest Entomostraca occurring in the lake would prove to be the natural food of the species.

In order to test this conclusion with precision, I arranged a similar experiment on a larger scale, and under more natural conditions. Through the generosity of the Exposition Company, of Chicago, I was allowed the use of one of the large aquarium tanks in the Exposition building, on the lake shore, and by the repeated kindness of Mr. Clarke, of Northville, Michigan, I was furnished with a much larger number of living whitefish. Five thousand fry were shipped to me in a can of water, but through unfortunate delays in changing cars at intermediate points, about two-thirds of these were dead when they reached my hands. Those living were immediately transferred to the tank, through which the water, taken from the city pipes, had already been allowed to run for several hours. As this water is derived from Lake Michigan at a distance of two miles from the shore, and had at this time the exact temperature of the open lake, the conditions for experiment were as favorable as artificial arrangements could well be made.

Sending a man with a towing-net out upon the lake with a boat, or upon the remotest breakwaters, immense numbers of all organic objects in the waters were easily obtained. After enclosing the exit of the tank with a fine wire screen, to prevent

the escape of objects placed in it, we poured these collections of all descriptions indiscriminately into the water from day to day, thus keeping the fishes profusely supplied with all the various kinds of food which could possibly be accessible to them in their native haunts. From this tank one hundred fishes were taken daily and placed in alcohol for dissection and microscopic study, to determine precisely the objects preferred by them for food. These were examined at a later date, and all contents of the intestines were mounted entire as microscopic slides, and permanently preserved. A careful study was, of course, made of the organisms of the lake, as shown by the product of the towing-net, and when the experiment was finally ended, it was followed by an equally careful examination of the living contents of the water of the tank at that time.

These fishes, like those previously described, had already reached the age and condition at which it is customary to "plant" them in the lake. The ventrals were still undeveloped, the egg sac had nearly disappeared, the four mandibular teeth were present, and the median fin extended from the tips of the pectorals on the belly to a point opposite the middle of the same fins on the back. In most the egg-sac did not protrude externally, being reduced in some to a droplet of oil, but remaining in a few of a size at least as great as that of the head. The alimentary canal was, of course, a simple, straight tube, without any distinction of stomach and intestines.

The sufferings of these fry in transit had doubtless weakened the vitality of the survivors, and although every care was taken to keep the water of the tank fresh and pure, about one-third of those remaining died during the progress of the experiment. The aquarium in which they were confined was built of glass, and had a capacity of about one hundred cubic feet. The temperature, tried repeatedly, stood at forty-two Fahrenheit. A steady current of the water of the lake was maintained through this tank, entering through a rose, from which it fell in a spray, thus insuring perfect aëration.

By far the greater part of the organic contents of the water of the lake, as shown by the product of the towing-net, consisted of diatoms in immense variety, which formed always a

greenish mucilaginous coating upon the interior of the muslin net. In this were entangled a variety of rotifers, occasional filamentous Algæ, and many Entomostraca, the latter belonging chiefly to the genera Cyclops, Diaptomus and Limnocalanus among the Copepoda, and to Daphnia among the Cladocera.

As the Entomostraca proved to be far the most important elements of this food supply, the particulars respecting them may be properly more fully given. The smallest of all was a Cyclops, then new, but since described by me under the name of *Cyclops thomasi.** This little Entromostracan is only .04 inch long by .011 wide. The next in size, and by far the most abundant member of this group, was a Diaptomus, likewise new, described in the paper just cited, under the name of *Diaptomus sicilis.* This appears in two forms, one, evidently young, in the stage just preceding the adult. Full-grown individuals were .065 inch long by one-fourth that depth. The Limnocalanus was a much larger form, evidently preying, to a considerable extent, upon the two just mentioned. All the Cladocera noticed were *Daphnia hyalina*, an elegant and extremely transparent species, occurring likewise in the lakes of Europe. A single insect larval form (Chironomus) should likewise be mentioned in this connection, since it had about the same size and consistence of the Entomostraca, and was consequently available for food. The specimens of each of the above species from a certain quantity of these collections were counted, in order to give a definite idea of their relative abundance in the lake; the Diaptomus numbered 225, the Cyclops 75, Limnocalanus 7, Daphnia 3, and Chironomus larvæ 1. It was a curious fact, however, that when the water was drawn off at the end of the experiment, more than half the Entomostraca were Limnocalanus; a fact partly to be explained by the predaceous habit of the latter, and partly by the facts relating to the food of the fishes themselves, which are presently to be detailed. The fry were placed in the tank and supplied with their first food on the evening of the 12th of March. On the

* "On some Entromostraca of Lake Michigan and Adjacent Waters." American Naturalist, Vol. XVI., No. VIII. August, 1882', pp. 640 and 649.

14th, one hundred specimens were removed, and twenty-seven of these were dissected. Twenty were empty, but the remaining seven had already taken food, all Cyclops or Diaptomus. Three had eaten Cyclops only, and six Diaptomus, while two had eaten both. Fourteen of these Entomostraca, seven of each genus, were taken by these seven fishes. From those captured the next day, twenty-five specimens were examined, of which nineteen were without food. Of the remaining six, three had eaten Diaptomus and three Cyclops; five of the former being taken in all, and ten of the latter. Three specimens were next examined from those caught on the 19th of March, two of which had devoured Diaptomus, and a third a single *Cyclops thomasi* and a shelled rotifer, *Anuræa striata*. The character of the food at these earliest stages was so well settled by these observations that I deemed it unnecessary to examine the subsequent lots in detail, but passed at once to the specimens taken on the 23d. Twenty-six of these were examined, and found to have eaten thirty-three individuals of *Cyclops thomasi*, fourteen of *Diaptomus sicilis*, and fourteen of the minute rotifer already mentioned (*Anuræa striata*). Two had taken a few diatoms (Bacillaria), and one had eaten a filament of an Alga. Cyclops was found in sixteen of the specimens, Diaptomus in nine, and Anuræa in eight, only two of them being empty. The amount of food now taken by individual fishes was much greater than before, one specimen dissected having eaten two Cyclops and six *Diaptomus sicilis*, male and female. Another had taken five Cyclops, one Diaptomus, and five examples of *Anuræa* striata. Still another had eaten four of the Cyclops, four Diaptomus, and one Anuræa.

Twenty-five specimens were examined from those removed on the 24th of the month, at which time the water of the tank was drawn off and all the remaining fishes bottled. Four of these had not eaten, but the twenty-one others had devoured fifty specimens of *Diaptomus sicilis*, forty-seven of *Cyclops thomasi*, fourteen of Anuræa striata, and a single *Daphnia hyalina*, the latter being the largest object eaten by any of the fishes. A few examples of their capacity may well be given. The ninth example had eaten six Diaptomus, two *Cyclops*

thomasi, and one Anuræa; the tenth had taken eight Diaptomus, two Cyclops, and an Anuræa; and the twentieth, seven Diaptomus and three *Cyclops thomasi*. In two of these examples were small clusters of orange globules, probably representing unicellular Algæ.

Summarizing these data briefly, we find that of the one hundred and six specimens dissected, sixty-three had taken food, and that the ratio of those which were eating increased rapidly, the longer the fishes were kept in the aquarium. Only one-fourth of those examined on the fourteenth of the month had taken food, while more than five-sixths of those bottled ten days later had already eaten. The entire number of objects appropriated by these sixty-three fishes was as follows: *Cyclops thomasi*, ninety-seven; *Diaptomus sicilis*, seventy-eight; *Anuræa striata*, twenty-nine; *Daphnia hyalina*, one. Seven of the fishes had eaten unicellular Algæ, two had eaten diatoms, and one, filamentous Algæ.

From the above data we are compelled to conclude that the earliest food of the white-fish consists almost wholly of the smallest species of Entomostraca occurring in the lake, since the other elements in their alimentary canals were evidently either taken accidentally, or else appeared in such trivial quantity as to contribute nothing of importance to their support. In fact, two species of Copepoda, *Cyclops thomasi* and *Diaptomus sicilis*, are certainly very much more important to the maintenance of the whitefish in this earliest stage of independent life than all the other organisms in the lake combined. As the fishes increase in size, vigor, and activity, they doubtless enlarge their regimen by capturing larger species of Entomostraca, especially Daphnia and Limnocalanus.

A few words respecting the relative abundance of these species at different seasons of the year and their distribution in the lake will have some practical value. We may observe here an excellent illustration of the remarkable uniformity of the life of the lake as contrasted with that of smaller bodies of water. While in ponds minute animal life is largely destroyed or suspended during the winter, the opening spring being attended by an enormous increase in numbers and rate of multiplication,

in Lake Michigan there is but little difference in the products of the collecting apparatus at different seasons of the year.* There is a slight increase in the number of individuals during spring and early summer, but scarcely enough appreciably to affect the food supply of fishes dependent upon them. They are not by any means equally distributed, however, throughout the lake, my own observations tending to show that there are relatively very few of these minute crustaceans to be found at a distance of a few miles from shore, and that, in fact, by far the greater part of them usually occur within a distance of two or three miles out. Indeed, the mouths of the rivers flowing into the lake are ordinarily much more densely populated by these animals than the lake itself, as has been particularly evident at Racine and South Chicago. Neither are they commonly equally distributed throughout the waters in which they are most abundant, but like most other aquatic animals, occur in shoals. In the deeper portions of the lake, many species shift their level according to the time of day, coming to the surface by night and sinking again when the sun is bright.

These facts make it important to the fish-culturist that the particular situation when it is proposed to plant the fry should be searched at the time when these are to be liberated, to determine whether they will find at once sufficient food for their support. A little experience will easily enable one to estimate the relative abundance of the Entomostraca at any given time and place, and they require nothing for their capture more complicated or difficult of management than a simple net of cheese-cloth or similar material, towed behind a boat. This may be weighted and sunk to any desired depth, so that the contents of the water either at the surface or at the bottom, may be ascertained by a few minutes' rowing.

State Laboratory of Natural History, Champaign, Ill.

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* For definite assurance of this fact I am indebted less to my own observations (which are, however, consistent with it so far as they go), than to the statements of B. W. Thomas, Esq., of Chicago, who, while making a specialty of the Diatomaceæ of the lake, has collected and studied all its organic forms for several years, obtaining them from the city water by attaching a strainer to a hydrant many times during every month throughout the year.

DR. SWEENY had seen catfish jerk snails out of their shells by getting hold of the animal and drawing it out bodily. He had also noticed thousands of shells of the fresh-water mussel, or Unio, popularly known as the "hydraulic clam," with a hole through on each side as large as a half-dollar, and the meat gone. Doubtless this was the work of some of the fishes that Prof. Forbes has examined.

MR. MATHER had fed the salt-water mussel, *Mytilis*, to the marine sheepshead, *Diplodus* or *Archosargus*, as the scientists have it, while he was connected with the New York Aquarium, and had observed that this fish used its sheep-like incisors to nip off the byssus which held the mussel to its anchorage, and then crushed it with its pavement of teeth back of the jaws. After extracting the meat the shells were expelled from the mouth, and he had never noticed fragments of shell in the exuvæ. He had fed the fish hard clams also, but these required cracking with a hammer, and the shells were ejected after the meat was devoured as in the case of the mussels.

DR. PARKER asked what the food of the lake whitefish consists of.

PROF. FORBES answered that he had made no study of the food of this fish, except in the fry, and he had fully reported on their food. The United States Fish Commission has shown that crustacæa form the principal diet of the adult fish.

MR. CLARK had examined some of the whitefish taken February, and found nothing but small crustaceans in their stomachs.

SOME EXPERIMENTS WITH THE FRY OF WHITEFISH.

BY DR. J. C. PARKER.

The question as to whether the young of the whitefish would find food and live when planted out of season much earlier than at the time at which they usually mature had been one of much discussion amongst those interested in fish-culture

in Michigan, it being generally thought that while the lakes were filled with ice that the temperature of the water would be so low that there would be no organisms upon which the young fish could feed, and, consequently, starvation would ensue. To test this question Superintendent Marks directed the overseer, Mr. A. W. Marks, of Petoskey Station, of the Michigan Fish Commission, to institute certain experiments and to report the same to the Board. The report is as follows:

On March 1, 1887, a small screen or crate made of wood and wire netting, three feet long and four and a half in diameter, in the form of a cylinder, was placed through the ice in Little Traverse Bay, in 100 feet of water, and 10,000 whitefish placed in the crate and lowered to the bottom with a strong rope. On March 5 the crate was raised and the young fry were nearly all alive, only six dead ones found. On March 10 the crate was raised again and twelve dead fish were found. The fry had turned to a light brown, the yolk sac was nearly absorbed and the fish seemed in good health. On March 12 the crate was again raised and some of the fry taken out and brought home; also a jug of water from the bottom and another from the top was taken. One drop of this was placed under a strong glass and life could be seen very plentiful. The stomach of one of the small fish and a drop of the water was placed under the glass and it was found to be full of diatoms and vegetable matter. The diatoms seemed to be working around the small pieces of vegetable matter; the sac of the fry had been absorbed and they were feeding upon the vegetable matter and the animalcule. On March 14 the crates were again lifted, and the fish seemed to be doing well in about the same condition as on the 12th. About 100 dead fish were found on the 14th. The crate was lifted on the 18th; no change could be seen. On the 24th the crate was again lifted, and some of the young had turned to a light green, the color of a herring a year old. On March 24 another crate was sunk, containing 5,000 fry. This was lifted on the 28th, and two dead fish were found in the crate. At this date the first crate sunk contained fish forty-five days old that had been under the ice twenty-eight days. About the last of March the ice moved out of the bay, thus preventing

any further systematic observations. Later on the submerged crates were recovered, but the wire screens had become filled with sediment, caused by the roiling of the water consequent upon the breaking up of the ice, and no live fish were found in them. This closed the experiments for that year, and circumstances prevented their continuance this spring.

Grand Rapids, Mich.

THE DIGESTIBILITY OF FISH.

BY PROF. W. O. ATWATER.

In the course of an investigation upon the Chemistry and Food-economy of Fish, which has been in progress for a number of years, under the auspices of the U. S. Fish Commission, a study of the digestibility of fish has seemed desirable, and a beginning has been made in the form of experiments upon the comparative digestibility of the flesh of fish and lean meat. The object of the present paper is to give a brief outline of the main results. These confirmed by quantitative test the general impression that in fish we have one of the most completely digestible of food-materials.

THE DIGESTIBILITY OF FOOD IN GENERAL.

The question of the digestibility of foods is very complex, and it is noticeable that the men who know most about the subject are generally the least ready to make definite and sweeping statements concerning it. One of the most celebrated physiologists of the time, an investigator who has, I suppose, devoted as much experimental study to this particular subject as any man now living, declares that aside from the chemistry of the process and the quantities of nutrients that may be digested from different foods, he is unable to affirm much of anything about it. The contrast between this and the positiveness with which many people discourse about the digestibility of this or that kind of food, is very marked and has its moral.

Our source of confusion is the fact that what people commonly call the digestibility of food includes several very different things, some of which, as the ease with which a given food-material is digested, the time required for the process, and the effect of different substances and conditions upon digestion, are so dependent upon individual peculiarities of different people and so difficult of measurement as to make the laying down of hard and fast rules impossible. Why it is, for instance, that some are made seriously ill by so wholesome a material as milk, and others find that certain kinds of meat or vegetables or sweetmeats "do not agree with them," neither chemist nor physiologist can exactly tell.* Late investigations, however, suggest the possibility that the ferments in the digestive canal may cause particular compounds to be changed into injurious forms, so that it may sometimes be literally true that "one man's meat is another man's poison." But digestion proper, by which we understand the changes which the food undergoes in the digestive canal in order to fit the digestible portion to be taken into the blood and lymph and do its work as nutriment, is essentially a chemical process. About this a great deal has been learned within a comparatively few years, so that here we have many important facts that have not yet got into current literature.

The average man swallows, say six pounds of food and drink, meat, fish, potatoes, bread, coffee, milk, water, and what not, per day. Every twenty-four hours, then, all the solid substance, all the protein, fats, carbohydrates and mineral matter

* Things do not always or, indeed, often come to hand exactly when they fit best, but, oddly enough, just as I am writing this the postman brings a letter from the Recording Secretary of the American Fisheries Society with the following statement: "By the way, I cannot digest oysters, raw or cooked, but can eat clams (both Venus and Mya) and can go to bed on the outside of a lobster mayonaise. Coffee ties a hard knot in the interior department, buckwheat cakes start my 'vinegar factory' to work on full time, beans cause the 'gas works' to be put in operation. This merely proves the adage about 'one man's meat, etc.'" The learned gentleman follows this by the statement that he has already passed the age of forty, at which a man is said to become "either a fool or a physician"; and gives a physiological explanation of his digestive temperament which he attributes to dyspepsia "aggravated by nine months' diet on corn meal, ground cob and all, and sorghum syrup, in Confederate prisons." Of course it would be wrong to affirm that in this especial case it is the microbe that causes the protein of the oysters to be changed into compounds which make them disagree, or produces the disagreeable fermentations in the buckwheat cakes and beans, but some how or other different food-materials do produce very disagreeable effects in the digestive apparatus of different people, and the science of to-day explains this in part by the action of the digestive ferments, among which microbes play an important role.

of this quantity of food, except the small portion that passes through the alimentary canal undigested, must be either dissolved or divided into such minute particles as to be able to get through the microscopic passages that permeate the walls of the canal and thus find their way to the blood. To judge accurately of the nutritive value of our food, then, we must know not simply how much of the different nutritive ingredients, the protein and fats and carbohydrates, it contains, but how much of each of these nutrients will be digested. This is a matter that can be determined more or less accurately by experiment. But a great deal of labor is needed to make the experiments accurate, the line of research is new, the methods are not yet perfectly matured, and the results thus far obtained, though extremely interesting and valuable, are still far from complete. The side questions, such as differences in the digestive apparatus of different persons; the effects of exercise and rest, or mode of preparation of the food, and of the flavoring materials and beverages taken with it, tend to complicate the problem of digestibility, yet even here experimental research has something to tell us. In brief, we have to-day a tolerably fair idea as to what proportions of the ingredients of a good many of the more common kind of animal and vegetable food-materials, meats, milk, butter, cheese, eggs, bread, potatoes, are ordinarily digested by healthy people. But the list of materials the digestibility of which has been accurately tested is far from including all the more common kinds of food, and more experiments are needed, even with the foods that have been tested, to show the variations in digestibility by different classes of people, and under different conditions. The only direct experiments on the digestibility of fish by men or other animals, so far as I know, are those described in this paper.

THE CONSTITUENTS OF FOOD.

But before going farther I ought, perhaps, to say a few words about the nutritive ingredients of fish and other food materials and the technical terms which we are coming to apply to them in the chemical laboratory. Fish, like meats and other

food, are made up of different constituents. These we may classify as follows :

1. Edible substance, *e. g.*, the flesh of meats and fish, the shell contents of oysters, wheat flour. 2. Refuse, *e.g.*, bones of meat and fish, the shells of oysters, bran of wheat.

The edible substance consists of: 1. Water. 2. Nutritive substance or nutrients. Leaving out of account the refuse and the water, we may consider simply the nutriments. Speaking as chemists and physiologists, we may say that our food supplies, besides mineral substances and water, three principal classes of nutritive ingredients, viz. : Protein, carbohydrates, and fats ; and that these are transformed into the tissues and fluids of the body, muscle and fat, blood and bone, and are consumed to produce heat and force.

The principal nutrient of fish is protein. In chemical composition the protein of fish is essentially the same as that which makes up the bulk of the nutritive material of very lean meat. In both lean meat and in fish it is called myosin. It is very similar to the albumen (white) of egg, the casein (curd) of milk and the gluten of wheat. The protein compounds are sometimes called "flesh formers." They are the most important of the nutritive ingredients of food, because they are the only ones that contain nitrogen and they alone make muscle, tendon and other nitrogenous tissues of the body. Of the fats we have familiar examples in the fat of meat and fish, lard, butter, olive oil and other kinds of oil, including the oil of corn and wheat. Some kinds of fish, as salmon, shad and mackerel contain considerable fat, but the flesh of codfish, haddock, pike, perch, bass, bluefish and the most of our common food fishes contain very little fat, less, indeed, than is found in even the leanest meat. Of the carbohydrates, sugar and starch are the most important. The carbohydrates make the chief nutritive material of vegetable foods. Oysters and clams contain a certain amount of carbohydrates, as does milk. These different substances in food have different kinds of work to do in nourishing the body. The protein compounds, which are the only ones that contain nitrogen, make the muscle, tendon and other nitrogenous tissues. This, the carbohydrates and fats, which contain no

nitrogen, cannot do. The carbohydrates and fats serve for fuel, yielding heat to keep the body warm and muscular strength for work. Protein compounds can also serve for fuel.

Since protein can do the work of the carbohydrates in furnishing heat and muscular power, and has a work of its own to do in building up the tissues of the body which the other nutrients cannot perform, the protein compounds are the most important of the food ingredients. And when we compare the quantities of the different nutrients in food with the market prices of foods, we find that protein is by far the most expensive. It costs, pound for pound, several times as much as fats and carbohydrates. The fats are more expensive than the carbohydrates and have a higher fuel value. In short, fish furnishes protein to form muscle and other nitrogenous parts of the body. Some kinds of fish contain considerable fat also. Since the protein is the most important and the most expensive of the food ingredients and fat is more costly and valuable than carbohydrates, it is evident that fish is an extremely valuable article of food. Indeed the importance of fish in domestic and in national economy has not yet come to be justly appreciated.

Our national diet is one-sided ; we eat too much of the fats and carbohydrates and relatively too little protein. This comes from our enormous consumption of highly fattened meats and of sweetmeats. As population becomes denser and economy becomes more necessary we shall have to devote relatively less of the productive power of our land to meat production. If we can replace part of the meat that we consume by fish, it will be greatly to our advantage as regards both health and purse. In the older and more densely populated countries of the world, as Europe and Asia, the food of the people is mainly vegetable, and is relatively deficient in protein. To produce meat to supply protein seems impossible. It thus appears, that, the world over, by fish-culture, the rivers and the sea are made to rightly supplement the land in the production of food for man. I hope in another place to enlarge upon these statements and to cite statistics to illustrate them, but must now go back to my subject, the digestibility of fish.

THE DIGESTIBILITY OF FISH.

There are two ways of studying experimentally the digestibility of fish as of other foods. One is by experiments in artificial digestion, in which the food material is exposed to the action of the digestive juices in the laboratory, in apparatus fitted for the purpose. The other is by direct experiments with man or other animals. A series of experiments upon the artificial digestion of fish in gastric juice have been made by Messrs. Chittenden and Cummins, and reported in Commissioner's Report of the Commission of Fish and Fisheries of the United States for 1884, page 1109. In the introduction to the account of their work these experimenters speak as follows:

"Few experiments appear to have been made on the digestibility of fish; this is the more strange when we consider what an important item of food fish constitutes, particularly along our seaboard. * * * * As Voit remarks, 'Nothing certain is known regarding the digestibility of different kinds of fish, although much is said concerning it. Probably digestibility is in part dependent upon the nature of the fat present and the manner of its distribution; thus the presence of a difficultly fusible fat with considerable stearin would tend to hinder digestibility (as in mutton); the same thing probably occurs when the contents of the sarcolemma are permeated with much fat (as in the lobster and eel).' This statement at once suggests the probability of great variation in the digestibility of the flesh of any one species, dependent on a large number of conditions, which, in the case of fish particularly, are somewhat difficult of control; thus age, sex, food, period of spawning, length of time they have been preserved, are a few of the many natural conditions which would tend to modify the digestibility of the flesh and render generalizations from even a large number of results somewhat uncertain."

The outcome of their work is expressed thus:

"The results of the analyses show plainly that the method adopted is as good as could be expected, for it must be remembered that the two results obtained from each sample of flesh are not merely from duplicated analyses, but from duplicated digestions as well, and in these, extending as they do over twenty-two hours, with slight variations in temperature and agitation, small differences are to be expected. The very great divergence noticed, however, in the results obtained from different samples of the same species of flesh show at once that there are other conditions, such as age, etc., which affect the digestibility of the flesh more or less, so that, in order to obtain results from which to draw strict generalizations, it would be necessary to experiment with fish of different species, of like age, sex, and reared under like conditions. As examples of this we have the very divergent results from

two samples of veal, and also of two bluefish (88.69 and 73.44). As direct evidence that age, sex, etc., do exert a modifying influence on the digestibility of flesh, we have three experiments on the flesh of the lobster; one with a small young lobster, a second with a large female, and a third with a large male of the same species. The duplicate digestions gave fairly concordant results; the average relative digestibility being for the young specimen 87.81, for the large female 79.06, and for the male 69.13. This shows plainly some modifying influence in the flesh itself. In composition, so far as the solid matter is concerned, there was no appreciable difference in the three samples. Bearing in mind, however, these possible variations, it is very evident from our results that the average digestibility of fish-flesh is far below that of beef similarly cooked. In but two instances, in the case of shad and whitefish, does the digestibility of fish-flesh approach that of beef, although, from the average of our experiments, several are as easily digestible as mutton, lamb, and chicken.

"Pavy states that fish with white flesh, such as the whiting, etc., are less stimulating and lighter to the stomach, or more easy of digestion, than fish with more or less red flesh, as the salmon. Our experiments confirm this statement so far as digestibility is concerned. Thus the average digestibility of the salmon and trout is considerably below the average of the more digestible white fish. The difference between the digestibility of the light and the dark meat of the same flesh is somewhat striking, as in the case of the shad, where the digestibility of the former was found to be 97.25, as compared with beef, while the dark flesh was 87.32. A similar difference, though very much smaller, is to be noticed between the light and dark meat of the chicken.

"This difference in digestibility is in part due, without doubt, to the amount of fat present, for, as Pavy states, in the flesh of white fish there is but little fat, it being accumulated mainly in the liver of the animal, while in red fish there is more or less fatty matter incorporated with the muscular fibres. For a similar reason, eels, mackerel and herring are, according to Pavy, less suited to a delicate stomach than some of the white fish, and our experiments show that in digestibility two of them stand below the more digestible white fish; mackerel, however, from our single experiment with the white portion of the flesh, showed a comparatively high digestibility. In all of our experiments, however, with white fish, we rejected the outer layer of dark flesh, except in the case of the shad. The varying differences in digestibility are not to be considered as due wholly to differences in the amount of fat in the flesh; thus the flesh of fresh cod contains but little fat, and yet it is one of the most indigestible of the white fish experimented with. This agrees with Pavy's experience 'that it is a more trying article of food to the stomach than is generally credited.' Again Pavy makes the following statement, based on his experience in fish dietetics 'of all fish, the whiting may be regarded as the most delicate, tender, and easy of digestion.' 'The haddock is somewhat closely allied, but it is inferior in digestibility,' while 'the flounder is light and easy of digestion, but insipid.' With all these statements our results agree

perfectly, assuming the whitefish of our experiments to be analogous to the English whiting."

It thus appears that Messrs. Chittenden and Cummins found considerable divergence in the digestibility of the flesh of fish of different kinds. These they attribute in part to the varying proportions of fat, the fatter fish being the less digestible, and in part to other characteristics of the flesh. My own impression is, that experiments on the actual digestion in the alimentary canal, in which other juices as well as the gastric come in play and other conditions are different, would show less difference in the digestibility of fish of different sorts than these investigators found in their experiments in artificial digestion with gastric juice alone, and also that there would be less variation in the actual quantities and nutritive material digested than the statements made by the authors quoted by Messrs. Chittenden and Cummins would imply. For we must not forget the distinction between the quantity digested and the ease of digestion. But, of course, this is a matter to be determined by actual experiment and observation.

The ways in which the experiments for testing the digestibility of foods by men and animals are made, are very ingenious and interesting. Physiologists use the salivary glands, or stomach or intestine of a living animal, much as chemists do their bottles and retorts and test-tubes. It is easy to get into the way of regarding an animal as simply an organism manifesting certain reactions under given conditions, and in not a few European laboratories a janitor is readily induced by the price of a few months' supply of beer, or a student by his scientific ardor to take this same altruistic view of his own physical organism. In the German laboratories, particularly, one finds not only the needed apparatus, but what is no less important, trained assistants and servants, so that one is relieved of much of the time-consuming and disagreeable detail of experimenting, which is so much of an obstacle with us.

THE QUANTITIES OF DIGESTIBLE SUBSTANCES IN FOOD.

The first question we have now to ask may be put in this way. What proportion of each of the nutrients in different

food-materials is actually digestible? In a piece of meat, for instance, what percentage of the total protein and fats will be digested by a healthy person, and what proportion of each will escape digestion? The proportions of food-constituents digested by domestic animals has been a matter of active investigation in the European agricultural experiment stations during the past twenty years. Briefly expressed, the method consists in weighing and analyzing both the food consumed and the intestinal execretion, which latter represents the amount of food undigested. The difference is taken as the amount digested.

Such experiments upon human subjects, however, are rendered much more difficult by the fact that in order that the digestibility of each particular food-material may be determined with certainty, we must avoid mixing it with other materials. Hence the diet during the experiments must be so plain and simple as to make it extremely unpalatable. An ox will live contentedly on a diet of hay for an indefinite time, but for an ordinary man to subsist a week on meat or fish or potatoes or eggs is a very different matter. No matter how palatable such a simple food may be at first to a man used to the ordinary diet of a well-to-do community, it will almost certainly become repugnant to him after a few days. In consequence, the digestive functions are disturbed, and the accuracy of the trial is impaired, a fact, by the way, which strikingly illustrates the importance of varied diet in civilized life. For instance, in an experiment conducted in the physiological laboratory at Munich, by Dr. Rubner, the subject, a strong, healthy Bavarian laboring man, lived for three days upon bread and water, a diet, the monotony of which was much more endurable than one of meat or fish or most any other single food-material would have been. He was able to eat 1,185 grams (about 2 lbs. and 10 oz.) of bread per day. This contained 670 grams of carbohydrates, mainly starch, of which only about 5½ grams, or a little less than one per cent., escaped digestion. In this case, therefore, about 99 per cent. of the carbohydrates of the bread were digested. The bread contained 13 grams of protein, of which 13 per cent. were undigested, and 87 per cent., or seven-eighths of the whole

protein, digested. The quantity of fatty matters in the bread was too small to permit an at all accurate test of their digestibility. In another experiment the digestibility of meat, beefsteak, was tested. The man consumed a little less than two pounds per day, but though it was cooked with butter, pepper, salt and onions so as to make it taste "extraordinarily well flavored," it was very difficult to swallow it the second day, and required great effort the third. The digestion, however, seemed to be normal, and all but about one per cent. of the protein was digested. Other trials with meat and with fish have brought similar results, and it is reasonably safe to say that when a healthy person with sound digestive organs eats ordinary meat in proper quantities, all or nearly all of the protein is digested. Some of the fats of meats, however, seem to fail of digestion. The number of accurate experiments of this kind is still very small. Some sixty or thereabouts have been reported. Nearly all have been made within ten years past, and the majority in one laboratory, that of the University of Munich. Most of the subjects have been men with healthy digestive organs, two or three laboratory servants, a soldier, several medical students and a few others. Several have been made, however, with children of a few families. All but a very small number conducted in Germany.

Some time since it was my fortune to pass a number of months in Munich, where, through the courtesy of Professor Voit, Director of the Physiological Institute of the University, I was enabled to make some experiments on the digestion of meat and fish by a man and by a dog. Each lived for three days upon haddock and then for three days upon lean meat, beefsteak. The dog was used to such experiments and got on very comfortably indeed. The meat and fish were each cooked with a little lard. He did not take to the fish at first, but after he got used to it seemed to like it. The first attempt with a man was with the same healthy, rather stolid Bavarian laborer, with whom Dr. Rubner's experiments with meat and bread, above referred to, were performed. He bore up very well through the trials with both the fish and the meat, but the assistant discovered at the end that he had surreptitiously eaten

sourkrout, and the experiment was spoiled. Fortunately, a medical student, then working in the laboratory, became interested in the subject, and offered himself as a martyr to the cause. He had, for three days, flesh of haddock, fried with butter, flavored with salt, pepper, mustard, and Worcestershire sauce, and taken with beer and wine. Then came a period of rest, that is to say ordinary diet, and then a similar trial with beefsteak. I was with him at every meal and can bear warm testimony to his fortitude and determination. The menu was made as appetizing as possible under the circumstances. The first day of each trial went pretty well, the second day it was difficult, and the third day almost impossible to swallow the whole. I used all sorts of devices to make it easier, especially by distracting his thoughts from the food; told stories of America, cracked jokes, made fun of him, at times almost angered him. And it is safe to say that all the effort was needed. As the result it appeared that he digested nearly the whole of both the meat and the fish. The results of the experiments are stated in tabular form herewith. The percentage of each ingredient, which escaped digestion, is given. In some cases a correction, for certain errors of experiment which need not be discussed here, is applied to the figures for amounts "apparently undigested," to show those estimated to be "actually" digested.

Summary of Results of Experiments on the Digestion of the Constituents of Meat and Fish by a Dog and by a Man. Percentages Undigested.

Experiments with Food.	Dog.		Man.	
	Meat and Lard.	Fish and Lard.	Meat, Butter, etc.	Fish, Butter, etc.
	Per cent.	Per cent.	Per cent.	Per ct.
Water-free substance, apparently undigested	3.4	3.2	4.3	4.9
Nitrogen (protein), from meat or fish, apparently undigested	2.2	1.6	2.5	2.0
Nitrogen (protein), from meat or fish, actually undigested	0.3	0.0	0.7	0.5
Fat, mostly from lard or butter, apparently undigested	2.8	3.0	5.2	9.0
Ash, apparently undigested	14.3	14.1	21.5	22.5

According to these experiments, therefore, practically all of the nitrogenous materials (protein) of both the fish (haddock) and the lean beef was digested by the dog, and all but one-half or three-fourths of one per cent. by the man. While more experiments are needed, the agreement of these results with what would be expected from the nature of the nitrogen compounds and what is known of the laws of digestion and absorption, leaves little ground to doubt that very nearly all, indeed we may say, practically all, of the protein of both will be digested by a healthy organism under normal conditions.

The conclusion that the flesh of the common kinds of fish agrees very closely in digestibility with that of the common kinds of meat, at least so far as the protein (the chief constituent of the "lean" of meat and fish) is concerned, seems equally well grounded. It would seem, however, from other considerations and especially from actual experiments with meats, in which the fat is imperfectly digested, that fish, having generally less fat than meat, is, on the average, more easily and completely digested. Perhaps it will be interesting to note how different food materials compare in digestibility as shown by experiments such as those just described.

Digestibility of Nutrients of Food-materials.

In the Food Materials Below.	Of the Total Amounts of Protein, Fats and Carbohydrates, the Following Percentages were Digested:		
	Protein.	Fats.	Carbohydrates.
Meat and fish	Practically all.	79 to 92 per cent.	.....
Eggs	"	96 "	.....
Milk	41 to 100 per cent.	93 to 98 "	?
Wheat bread	81 to 100 "	?	99 per cent.
Corn (maize) Meal	89 "	?	97 "
Rice	84 "	?	99 "
Pease	86 "	?	96 "
Potatoes	74 "	?	92 "
Beets	72 "	?	82 "

The amounts of fat in the vegetable foods are so small that the experiments do not tell exactly what proportions are digested. The meats and fish contain practically no carbohydrates. The digestibility of the carbohydrates (sugar) of milk was not determined, those of the vegetable foods except the beets, were almost completely digested. That the protein of cow's milk should be so much less completely digested than that of meal seems a little strange. Children have been found to digest a little more than adults, though the difference is not large. Thus Dr. Camerer, a German experimenter, found his boys and girls of from two to twelve years of age to digest from ninety-one to ninety-seven per cent. of the protein of cow's milk, while grown men in experiments by Dr. Rubner digested from eighty-eight to ninety-four per cent. But in experiments in which milk and cheese were eaten together by a man, the laboratory servant of Dr. Rubner's experiments, all or nearly all of the protein of both was digested. The percentages of fats of milk digested was practically the same with adults as with children. It is worth noting in these experiments, both children and adults digest only about half of the mineral salts of the milk. Why so much of the fats of the meat, from a twelfth to a fifth, should have failed to be digested it is not easy to say. Some of the food materials, as meat, bread and milk, have been tested each by several experiments with more than one person. With others, as eggs, corn meal, rice, pease and potatoes, only a single trial has been made. Doubtless extended series of tests would give averages differing more or less from these figures. Another thing that makes the results a little uncertain, is that some of the food materials may perhaps be more completely digested when taken in small quantities with others in the ordinary way than when so much of them is eaten and without any other food. These and other sources of slight error make more extended experiments very desirable. But enough has been done to show pretty clearly that :

1. The protein of our ordinary meats and fish is very readily and completely digestible.

2. The protein of vegetable foods is much less digestible

than that of animal foods. Of that of potatoes and beets, for instance, a third or more may escape digestion, and thus be useless for nourishment.

3. Much of the fat of animal food may at times fail of digestion.

4. The carbohydrates, which make up the larger part of vegetable foods, are very digestible.

5. The animal foods have, in general, the advantages of the vegetable foods, that they contain more protein, and that their protein is more digestible.

6. The comparative digestibility of fish and meats, and of the different kinds of fish, is not well enough decided by experiment to warrant as definite conclusions as are desirable. It seems probable, however, that the leaner meats are rather more easily digested than those which are more fat, and that, in like manner, the leaner kinds of fish, such as cod, haddock, perch, pike, bluefish, sole, flounder, etc., are more easily and completely digested than the fatter kinds, as salmon, shad and fat mackerel, and that for like reason fish, which is, in general, less fat than meat is, on the average, more digestible.

7. People differ in respect to the action of foods in the digestive apparatus, and fish, like other food materials, are subject to these influences of personal peculiarity.

One point more is worthy of remark before closing. The nutritive value of food is, of course, decided by other factors as well as by the proportion of digestible ingredients. In one respect fish is peculiarly adapted to the diet of that very large class of people whose occupation involves but little muscular exercise. As already explained, we consume excessive quantities of fat. This comes with our habit of eating highly-fattened meats, as well as butter and lard. Even when we attempt to reject the fat of the meat which comes upon our tables and is served on our plates, we consume a great deal of fat in the visible and invisible particles diffused throughout the lean. Statistics of dietaries in this country show the fat consumption to be enormous. Fat serves as fuel, and is useful for those who do hard muscular work, or are exposed to severe cold. For others it is not needed, and excess is a burden imposed on the

system. The excessive eating of fat is contrary to good economy, and hygienists assure us it is a very serious damage to health.

Fish supplies the protein which meat furnishes, and which is needed to build the tissues of the body, without the large amounts of fat which are not needed by people of sedentary habits. For brain-workers it seems to be on this account a very useful food.

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SOME OBSERVATIONS UPON THE GRAYLING.

BY J. C. PARKER, OF THE MICHIGAN FISH COMMISSION.

The question as to whether the grayling (*Thymallus tricolor*) could be successfully propagated artificially being practically undecided by this Commission, it was decided to prepare waters as nearly in accordance with natural conditions as possible and make as careful and systematic an attempt as we could to solve it. Accordingly ponds were made on the Buck Horn creek, of just sufficient depth to admit of screening and through which the whole creek flowed, with the hope that if placed here, they would in the spring—the spawning season—give us an opportunity to observe and handle them, under less difficult circumstances than in their native streams. We hoped that as the Buck Horn had originally been a good grayling stream, it would place at our disposal the most advantageous conditions. The ponds being in readiness, the several members of the Michigan Fish Commission proceeded on the 20th of August to the west branch of the Manistee, fifteen miles from the railroad station at Kalkaska, with boats, cans and camp equipage, prepared to make a week of it. The fish were to be captured with rod and line, it having been demonstrated that this was more certain, and the results more satisfactory, than any attempt to use nets of any description. The result was that at the end of the week we had caught and had in excellent condition about one hundred fine specimens. From five to six of these were put into a can,

the temperature of the water—which was comparatively low—kept down by the addition of ice, and nine of these cans loaded into a lumber-wagon and the journey to the station over a bouncing corduroy road commenced. Only one opportunity to change the water *en route* was afforded, but, notwithstanding all this rough handling, they reached their destination with only the loss of some four or five specimens.

During the winter they were watched and cared for, but the loss was about twenty-five per cent. When the spawning season arrived a close watch was kept to see when any signs of spawn-laying should commence, but we watched in vain. So far as could be ascertained there was nothing to indicate that they had, would, or could, ever spawn, and to-day we are no nearer a practical solution of the vexed question than when we commenced. During this, and a subsequent visit to the same locality, I was enabled to make some observations upon their food and their habits in feeding, which may be of interest. Near the camp was a pool in which two small fish had their haunts, one about six inches in length, and the other half the size. The larger one when at rest was on a bit of clean sand in plain view; the other lay under some sunken drift wood, dark in color, and under which he concealed himself, only the tip of his nose being visible, and the contrast in color corresponded exactly with their resting places; the larger one was so nearly the color of the sand on which he lay as hardly to be distinguished from it; only when in motion as he arose to the surface for his food; the other was as dark as the sticks under which he lay, showing that the question of color is one of bottom locality and undoubtedly a circumstance of more or less light. I was somewhat surprised at the tenacity with which they adhered to a locality when once domiciled in it. Three or four times I drove them out of their haunts; one afternoon chasing the larger one several rods up the stream only to find him in the same spot the next day, and when I returned to the same locality, after an absence of four weeks, I found the same fish apparently in the same places. In rising for food I never saw either of them more than a yard from their haunts, and only rarely but a few

inches. They would detect their prey at a considerable distance and slowly rise to meet it as it floated to them, and then a sudden flash, and they were back to their respective resting places. The deviation from the point where they lay was, from side to side across the stream, hardly ever but a few inches up or down. One day, when they were rising with more than usual frequency, I carefully crept out on a projecting log until I was nearly over them, and could watch their every movement, and, with watch in hand, counted the "rises" of the larger one for fifteen minutes. In this time he came to the surface and secured his prey fifty times. Sometimes he would rise nearly to the surface and then slowly settle down again, but whenever he actually seized anything he was back to his haunt again with a motion so quick the eye could scarcely follow him. After considerable observation I could detect the particular insect I was sure he would rise for, sometimes before he would show any motion in that direction. Watching his quick, unerring sight, and his ability to detect what was food, and what was not, led me into some generalizations on what their food really was, that were new to me.

In eviscerating fish for any purpose, I have always been in the habit of examining the contents of the stomach, and the stomach of the grayling had always puzzled me by the quantity of vegetable matter so often found in them; but the *a priori* conclusion was that he was necessarily a carnivorous, or insectivorous fish; the thought that he was a vegetarian as well, never occurred to me. I had observed that the fronds of the white cedar—*arbor vitæ*—were quite usually among the contents of the stomach, but I had always considered it as something adventitious, an accident, occurring in the procuring of his food, and not deliberately taken. But a somewhat singular circumstance that occurred upon this last expedition staggered me somewhat. On the afternoon of the day of my arrival, after the tent was pitched, and camp life organized, I proceeded to a pool below a flooding dam near camp, thinking I could secure enough grayling for the supper of myself and little daughter, who accompanied me. I succeeded in securing two

nice ones, weighing probably about six or eight ounces each, and upon dressing them and examining the stomachs as usual, judge of my surprise upon finding one of them full of oats; there were eight kernels stored away in first-class style, and my first question was, where in the name of the Prophet could they have come from, for I knew that there wasn't a spear of grain growing within a dozen miles of this pool and the condition the grain was in showed that they could have been in the stomach but a short time. I finally solved the mystery by remembering that the man who brought us out—we arrived about noon—fed his horses some oats at a point just above the pool, and the grain was either blown into the water or carelessly thrown in by some one. I frequently found in their stomachs portions of the leaves and seeds of the water plants growing in the streams. Among the latter was in several instances a round seed about as large as a No. 4 shot, which I at first thought was a mollusk, a species of spherium, but on examining it with a glass what appeared to the naked eye to be the striations of the shell proved to be the veination of the seed. It may be urged against the vegetarian theory that many fish take that which in no way resembles their ordinary food, as the artificial fly and the different varieties of spoon and spinning baits, and that this particular fish could in no way have had any previous knowledge of oats as food, and consequently the taking of it must be in the nature of a freak rather than a habit, but I do not remember to have ever found in the stomachs of other fish any substance other than their food but which could be accounted for as accidental, while in the grayling the presence of vegetable matter in some forms is of so frequent an occurrence as to point strongly to the fact, that a part of their food at least is vegetable.

Another point in favor of this theory is the peculiar flavor of the fish and that which has given it its specific name. It is a well-known fact that the flesh of all animals is to a greater or less degree flavored by its food. Now, if this fish fed upon exactly the same materials as the brook trout, could there be a reasonable doubt but what its flesh would taste like that of the trout, while the fact is, that it is distinctly different.

You are probably aware of the difference between a liver-fed trout and one caught in its native wilds; a difference so patent, that a person relying upon the taste alone would pronounce them an entirely different fish. One thing is certain, whatever its food is, it must have existed in unlimited quantities to have supported such a large multitude of this fish as absolutely swarmed in the northern streams of this State at an early day. D. A. Blodget, now living at Grand Rapids (and one of the pioneers of the Muskegon at the Hersy-branch) told me that when he first built a dam at the mouth of this stream, that in the spring, during the spawning season, when the grayling were trying to find their way to the spawning grounds, that he has seen the inhabitants fill the box of a common lumber wagon *full* of this fish in a few hours and carry them out into the country, not only one such load, but half a dozen of each spring for several successive years, while as many more must have been taken away in smaller quantities, and he estimated the quantity taken by tons each year; that during the first winter he spent there, he supplied his table with this fish by taking a common nail-rod and sharpening it with his axe, and cutting a barb on it with the same tool, and going to any of the bends in the stream, and cutting a hole in the ice, he could in a little while get all he wanted by thrusting this primitive spear at random into the waters beneath; and as the number of fish that any stream can furnish is to a great extent limited only by the food supply, it seems that so great a number as was then found, not only in this particular stream, but in most all the streams in which they were found, must have had some food in much greater abundance than what is usually found in our ordinary trout streams.

Grand Rapids, Mich.

Mr. Marks stated that there were many grayling in Michigan yet, that the extermination had gone on in the Au Sable, made famous by the writings of Norris, Milner, Hallock, Mather and others who fished there in an early day, because of the driving of logs in that river. These logs are driven in the spring, when the fish are spawning, or after that event, and they plow up the gravel beds and destroy millions of eggs

which are there developing. In his labors as Superintendent of the Michigan Fish Commission he could bear witness that while the grayling may be going from some streams on account of the operations of man, it was not true that the fish was in danger of immediate extinction, as has been the case with the buffalo and some land animals, but the destruction has been only on certain rivers, and has not been caused there by fishing but by logging.

MR. DUNNING asked why not plant the eggs of fishes in the waters instead of hatching them first?

DR. SWEENY replied that Dr. Sterling had recommended this plan, and that he had tried it and had produced better results than when the fish were left to impregnate their eggs, yet experience has taught that it is better to keep them until the fry are hatched, because in the troughs or jars the eggs and fry are not only placed under the very best conditions for hatching, but are protected from their enemies as well. A young fish that has been brought so far forward that it can hide from its enemies, certainly has a great advantage over an egg in the matter of self-protection, and to place the eggs directly in the waters would be a step backward in fish-culture.

DR. HUDSON said that the Connecticut Commission had some experience in the destruction of eggs and fry. In the early days of shad-hatching, before the invention of the McDonald jar, they used the floating-boxes, and used to put on rubber boots and wade out to examine them. Thousands of little fishes followed and devoured every egg that was taken out when the dead ones were removed. If we keep the fry and only turn them out when the sac is absorbed we will avoid a great destruction of both eggs and embryos.

MR. MATHER corroborated this by saying that years ago, when the floating-box was the best device known for hatching shad, he had observed in his work on the rivers, from Connecticut to Virginia, that underneath the boxes lay a host of small perch, sunfish and minnows, which were nibbling at the tails of such little shad as protruded through the netting, and the loss from this source was often considerable. By the use of the jars this no longer occurred, and although a young fish

had to take its chances when turned out, it should be protected until it needs food ; besides this, fungus will destroy many eggs, as will also the sun and sediment.

Mr. Clark related an experiment made by the late George Clark, once one of the Board of Michigan Commissioners, when his (the speaker's) father was taking whitefish eggs at Mr. George Clark's fishery at Ecorse, on the Detroit river. The latter gentleman wished to test the planting of eggs, and made a box with screened sides and put gravel on the bottom, and placed the eggs on the gravel and sunk the box where there was a gentle flow of water. In February the box was taken up and there were no good eggs to be found in it, those which died first had developed fungus, and this had spread and killed every egg. Fungus is a deadly thing which is not allowed to appear in any hatchery which makes pretension to be well conducted.

Dr. Sweeny explained that while the black bass and the sunfishes guard their eggs and keep off all intruders the trout and whitefish, in fact all members of the Salmonidæ, left them to their fate, and here is where man steps in as a guardian and prevents destruction at the most critical period.

CO-OPERATION IN FISH-CULTURE.

BY JOHN H. BISSELL, OF THE MICHIGAN FISH COMMISSION.

Within the limits properly allowed for a paper in a meeting like this, it is scarcely possible to do more than sketch or outline a subject such as I have chosen. I am consoled, however, with the reflection that the manner and style will be passed with indulgence if only there be some merit in the subjects presented for consideration, or at least good faith on the part of the reader.

I think it is generally agreed, that fish-culture has passed its purely experimental stage. It is in fact fast becoming recognized as a practical art, and an established department of civil government, its definitely ascertained results, which are now unquestioned, fully warranting the recognition it has

received from the States and the United States. Having so attained to the period when it is capable of being made a useful factor in the economy of every civilized State, the persons charged with the public duty of administering its affairs and evoking useful results from its prosecution ought ever to be looking for reasonable and practical ways to secure it the highest degree of efficiency. The United States Commission with a new and broader organic law recently adopted and put in operation, with its departments of work newly recast and systematized, and under most zealous and competent guidance, is prepared now to apply in the solution of some economic problems, the many lessons of experiment and scientific observation, gathered and stored up in the past. The States which have been dealing practically with the fishery question in the last ten years have made good progress towards reliable and permanent methods of fish-culture, and now at length are able to bring forward some definite and tangible proof concerning its results.

Fish-culture, when appreciated and invoked in both its branches, artificial propagation and legal regulation, has demonstrated its ability to restore exhausted fisheries. Of that there is no need of citing evidence to this audience. The next forward movement toward the realization of the great promises of the practical Art of Fish-culture, in this country is, I believe, to be the working out of a just and comprehensive system of regulation of fishing as an industry, and as a recreation. A notable feature of this movement will be the attainment of more substantial co operation amongst the organized bodies existing for its prosecution under the State and Federal Government.

I have in mind two principal topics: 1. Co-operation between the United States Commission of Fish and Fisheries and the several State Fish Commissions; and, 2. The limited co-operation possible between the Commissions of neighboring States, or between States having similar fishery interests. I am not unaware of the fact that the United States Fish Commission has heretofore co-operated with the State Commissions. But I wish to call attention to the fact that such co-operation can be carried out on broader lines with advantage to all concerned.

You are all as familiar—perhaps many of you more so, than I—with the organizations employed in prosecuting fish-cultural work in this country, so that no detailed account of them is necessary. Here is the United States Fish Commission with men, with means, with appliances and with scientific knowledge, and while doing the same kinds of work that various State Commissions are doing, yet doing much more than any single State organization. Here are the State Commissions each prosecuting the particular kinds of work required by local conditions under which in the different States fish-culture is being carried on. At the points where these different organizations have work common to each, why may there not be cordial and effective co-operation? Not merely the negative, of not interfering with each other, but the positive working together to economize expenditures and effort, and thus increase general and permanent results.

Bordering the Great Lakes are six States having a population of about fourteen millions of people. The fisheries of these Great Lakes, as their product enters into the general commerce of the country, cannot be regarded as the concern of the six States—they are of national importance If the fish captured in these lakes were consumed along their shores I grant that the States would have no special claim upon the general Government for taking part in maintaining such fisheries, or helping in any way to their re-establishment. This was the condition of affairs once; but with the modern facilities of rapid communication and improved methods of transportation, their product is marketed all over the country, and for that reason the States bordering the Great Lakes have, in my judgment, as good a right to assistance from the General Government, in the directions I shall presently mention, as the fisheries of the Atlantic and Pacific Oceans. Our lake fisheries are not to be compared in extent and value to those of the seas, but it is a difference in degree not in kind. The United States is doing a most necessary work in the investigation and promotion of the Atlantic fisheries, is preparing to investigate more thoroughly, and help develop the fisheries of the Pacific; it has done the country an invaluable service

in examining and illustrating the seal and other fisheries in connection with the last general census ; for all of which it has earned the confidence and commendation of the country. Why should not a similar service be performed by it in co-operation with the States bordering the Great Lakes in making an exhaustive survey and examination of the fisheries from Duluth to the St. Lawrence river? "The reward of having wrought well is to have more work to do." If the Commission has not the equipment in steamers, the work already in hand probably requiring them all, why not borrow one or more of the revenue cutters that are lounging up and down the lakes? I may be doing that branch of the service an injustice, but I never have heard within ten years of those vessels doing anything more useful than cruise on a sort of dress-parade between Buffalo and Chicago.

If a revenue cutter could not be spared, then why not borrow from the Navy Department a despatch-boat, or some of the many steamers not suitable for modern naval warfare, and have her fitted out for this service. To do what? To be manned with the necessary crew, under command of an officer not above such service, placed under the direction of the United States Fish Commission, supplied by him with one or more naturalists, and one or more men competent to study and report upon the conditions, capacities and needs of the industrial fisheries, supplied with drags, sounding appliances, proper thermometers, duplicate charts of the lakes, and complete fishing apparatus. Upon the charts could be marked spawning-beds, seining grounds, the lines of inshore and outside fishing, abandoned fishing grounds, the lines where certain kinds of fish are most plentiful or scarce, the pound-net fishing stations and the like. With such an equipment it would be practicable to make a complete survey of the fishing, feeding and spawning grounds of the great lakes ; exhaustive scientific observations and collections of the fauna ; a census of the fishing industry, its methods, its product, its habits; in fact, a history that would, by its manifold and exact observations of the present condition and requirements of the industry and its possibilities, lead conclusively to a knowledge of the causes

of its decadence, and what is necessary to be done for its restoration and permanent maintenance. Is it worth the expenditure? I think I can answer without hesitation for Michigan waters. I had occasion in 1886 to examine the history of Michigan fisheries, and was led to the conclusion, after careful examinations and comparisons of such statistics as are obtainable, that if our waters had been as productive in 1885 as they were in 1859, with the effectiveness of apparatus and extent of operations in the former year, the money value of the products of Michigan waters in 1885 would have been not less than fifteen millions of dollars, instead of about one and one-half millions. In 1887 I compared the product of the Michigan fisheries for the year 1885 with those of the Province of Ontario, and found that the money value of the former, if computed upon the same basis as that employed by the Canadian Department of Marine and Fisheries, exceeded that of the province by more than one hundred thousand dollars.

The States bordering the Great Lakes having an immediate interest to be subserved by such an examination, as the work is being prosecuted in their waters, should co-operate by furnishing a crew of three or four men to assist in gathering statistics and other information, which would be of great value to the State Fish Commissions in illustrating to the Legislatures the kinds of regulations required to restrain wasteful fishing, which has gone so far towards depleting the waters, as well as the kind and extent of operations to restore productiveness of the waters. They might also direct or assist in the fishing operations of the expedition. Such an examination would also demonstrate the exact extent to which artificial propagation of whitefish benefited the fisheries, and indicate what points along the lakes required attention in order to the more even distribution of future supplies. The information so gathered would help, by furnishing the required data, towards another and most important feature in the regulation of the fisheries of the Great Lakes, namely, the licensing of fishing as an industry. In alluding thus briefly to this subject there is not time to more than call attention to the fact that a fair system of licensing would in time defray all or the larger part

of the expenses of keeping up the supplies of fish when the waters were once well stocked, as well as such part of the cost of enforcing the laws as the State would be called on to pay. There are several minor ways in which co-operation can be advantageously adopted, but not of sufficient importance to be enumerated here. They are being employed more or less, and are familiar to you all.

For many years the U. S. Commission has thus co-operated with two or three of the New England States in procuring salmon and Schoodic salmon eggs, on terms, I believe, equitable and satisfactory to all parties, and with most excellent results.

Another direction in which co-operation can, I believe, be advantageously employed is in a thorough examination of interior lakes. By interior, or inland, lakes the dwellers along the Great Lakes are wont to distinguish the smaller bodies of water wholly within the boundaries of the several States. In Michigan, the numbers, size, and natural conditions of the inland lakes make them a considerable part of the waters we are called upon to care for. In the earlier days of this work these lakes were planted with various kinds of fishes, not with any special reference to their adaptability to the fish planted, but because the Commission had fish for that purpose, and in a general way the people in the vicinity of the lakes wanted fish. I do not say this with the design of casting any reflection upon the authorities of those days. The promiscuous planting of fish was then perfectly natural; and our experience is based largely upon their mistakes as it is still more largely upon the notable success of so many of their experiments. As the years went by a very natural curiosity arose amongst citizens and fishery authorities to know what had been the result of those plants. Had all failed? If so, why? If the fish planted had not lived and prospered, would no others live in those waters? And, finally, the question formulated itself, are these waters suitable for any fish? If so, what kinds? There was but one way to answer these questions, and that was to go and find out. And so we went (by proxy). In 1885 in a desultory kind of a way the work

of examining the lakes was begun. In 1886 a proper crew was organized, consisting of three men, one being in charge. They were provided with a gang of gill-nets having meshes of four different sizes, thermometers, a small drag or trawl, sounding lines, fishing tackle, blank reports with printed instructions, and a complete camping outfit. And so with fairly good and practical results the lakes of three counties on the southern border of the State were examined and reported on. For a short time towards the end of summer a second crew was sent out to examine some places where there were special reasons for knowing the contents and capabilities of several lakes. In 1887 further improvements were made in the outfit, and the crew increased to four. The addition of one man secured more expeditious work. The result of these examinations give the Michigan Commission in permanent and convenient form, not only the exact, but the essential, facts about the lakes in eight counties of this State. The size, depth, character of bottom, quality of water, temperature, inhabitants, kinds and quantities of food; in a word what fish are there, and the knowledge what can and ought to be there in order to obtain the greatest productiveness of the given waters.

One characteristic these examinations have lacked. They afford an opportunity for scientific investigation, which would add materially to their practical utility, and which would certainly make them more complete from all points of view. We have not the means to supply that want. The United States Fish Commission has the means and the men. We are discussing with the Commissioner, and the head of the Department of Scientific Research of the United States Fish Commission, a practical method of co-operation in carrying on further examinations of Michigan lakes. Here is a field well worth cultivating. If fish-culturists are to do anything for the interior lakes they must know as well as possible the conditions under which their efforts must be tried. There are six or seven northern States besides Michigan, of which I have some knowledge, where such efforts ought to be made.

And while the lakes are being examined, why not the streams and rivers? Our experience has proved that there are

hundreds of spring brooks in this State suitable for the growth of speckled trout where that fish was not native. A systematic examination of all streams would in this State within a few years secure the planting of trout only in waters entirely adapted in temperature and food supply to trout. It would in my judgment also result in our being able to establish black bass in miles of water suitable for this admirable game and food fish where now they are unknown. Definite and comprehensive knowledge of the rivers and streams of the State, put into the same permanent and accessible form as the reports Michigan is getting of the lakes, is of importance just as the work on the lakes is.

Secondly, what co-operation can there be between State Fish Commissions? The most obvious points for co-operation between States, are where they border the same waters, as on the Great Lakes, or have a common boundary on a river,—as the Ohio, Mississippi, or Missouri. And here we must touch upon the regulation of fisheries, a subject pregnant with difficulties. For the States bordering the Great Lakes, a uniform system for every mile of the great waters ought to be established. Not necessarily identical enactments; for the waters of a single State, like Michigan, require a diversity in regulations to make complete for all its waters the operation of a general system. The objects to be sought by each State are the same, the means to reach these objects will necessarily be somewhat modified by local conditions. From our own experience, I assume that it is a difficult thing to secure the passage of suitable laws by the State Legislatures for the preservation of industrial fisheries. We have no difficulty in obtaining fairly good laws for the protection of game fish; but we have tried in vain thus far to persuade the Legislature of this State to do for the fisheries of the Great Lakes what must be apparent to any man of common sense, who gives the subject any attention, is essential to preserve them.

I think the common judgment of men, who are entirely disinterested but careful observers of the past and present condition of our fisheries, accords with that which is always expressed by the most intelligent and candid of practical

fishermen and fish dealers, to the effect that our laws should cover three vital points:

1st. To regulate the size of the meshes of nets, the times and places of fishing.

2d. The market size of the various valuable kinds of fish.

3d. The employment and authorization of competent State officers to enforce the regulations and inspect the products being marketed; and there should be confided to the chief officer discretionary power to suspend, within prescribed limits, the regulation respecting the apparatus, when such suspension will not result in the destruction of immature fish, and may be an advantage to the fishermen.

Regulations should be as general, as exact and as simple as is compatible with efficiency, in order that they may not be oppressive or obscure. Of course, each State must enact its own laws. Each State has exclusive jurisdiction of its waters to its boundary line; this on the Great Lakes is a matter of great importance. It has many times been suggested by persons who had not examined thoroughly the question of jurisdiction, that Congress could better provide for the regulation of the fisheries of the Great Lakes, because these waters bordered so many different States. This question has been settled once for all by the Supreme Court of the United States, so that whatever of advantage Federal legislation on this subject may seem to offer, it is a legal and constitutional impossibility, and must be dismissed. The States must do all there is to be done, and do it in their own several ways. Thus far it has been badly done,—or to speak more accurately, has not been done at all. Can there be any co-operation between the States to remedy this evil? There ought to be, is plain. And the fact of its recognized necessity ought to bring about, eventually, an affirmative answer. The force of a substantial and efficient example is the only constraint that can be brought to bear. When any one of the States bordering the Great Lakes will enact laws that are effective, its example will be followed.

Full and candid discussion between the fishery officers of the different States will be useful, and ought to be employed

more frequently than in the past, for the purpose of harmonizing the views of all. By fishery officers I do not mean alone the Fish Commissioners, but include the wardens or officers employed to enforce the laws, by whatever names they may be known. And I believe that good results might be obtained from conferences between the Fishery Committees of the Legislatures of Michigan and Ohio, and Michigan and Wisconsin, and Ohio, Pennsylvania and New York. At least this is worth consideration.

A step in the right direction was taken by Michigan, in 1887, in the passage of an act for the appointment of a Game and Fish Warden. The act was not as broad nor the powers as extensive as the Commissioners urged upon the Legislature; but it was one point gained. The thorough, consistent and intelligent course pursued by the gentleman selected by the Governor as the State Warden will go far towards securing at another session of our Legislature the required improvements in the law, as it has already demonstrated the important advantages of the proper enforcement of such laws as we have. Wisconsin took the lead in this class of legislation, but from all I have learned of its operation, I judge that the statute needs amendments in some important points to make it effective. Ohio, too, has started in the right direction. This is all encouraging, because in each case it has been a movement in the right direction.

The fisheries, in my judgment, have reached a point where no half-measure will answer. What is needed is to look the necessities of the case squarely in the face and provide wholesome and sufficient remedies, that will put a stop to the destruction and marketing of immature fish of all valuable kinds; and while it gives nature a chance to help repair the mischief already done, will likewise help to secure to the States the benefits of the artificial propagation and planting.

A third suggestion in the line of coöperation that I think worthy of discussion is between the Fish Commissions and the educational institutions of the State—as for instance, with the instructors in Natural History in the State University, or the Agricultural College. There are many ways in which the

two could aid each other. The University, or Agricultural College, or both, might furnish the naturalist to accompany a crew of Fish Commission men in examining interior lakes and streams. They might do a notable service by furnishing a naturalist, who is expert with the microscope, along with our crews employed in gathering ova of different fishes; and by a critical study of ova and milt during the spawning time, instruct the men as to the appearance of perfectly matured male and female properties, so as to bring such operations still nearer to perfection. At the same time, facts so acquired might be an actual and useful contribution to scientific knowledge. The Michigan Superintendent last fall proposed a very similar method for the purpose of improving the already good results in artificial fertilization.

Detroit, May 16, 1888.

Dr. Sweeny was down on the programme for a paper on "Stocking Western Lakes and Streams," but he claimed that he was ignorant that such information had been required of him and he was not prepared to present it in a formal manner. He had no objection to talking on the subject, and said that the work of the Minnesota Fish Commission, of which he was a member, had been very successful, the failures, if there had been any, were small and of no account, but the successes were so much in excess of any failure that his memory refused to get down to so small a matter. There had been great success in the hatching and planting of brook trout, black bass, and wall-eyed pike; the returns from the fisheries showed that the continuous plantings had borne fruit and that these fishes have increased through artificial propagation. In Lake Superior the plantings of whitefish have borne fruit and the fishermen who opposed the work at first were now strongly in favor of it. The increased catches have convinced the fishermen that the work of hatching whitefish should be continued. Dr. Sweeny had a theory that it would be well to stock certain points with whitefish and then have no fishing done there for five years, next year take other points and stock them, and so on in a circle. It seemed to him that this would be worth a trial.

MR. CLARK asked how the fishermen could be managed. Would they abstain from fishing at certain points at the request of the Commission, or would laws have to be passed to regulate this? Again, would not the fishermen oppose such legislation and render it difficult, if not impossible to procure it? Take the pound-net men, for instance; at Bass Island there are four or five pounds and the owners would probably object to being deprived of their fishing grounds for a term of years, and in practice it will be found difficult to control the fishermen.

DR. SWEENY thought that now, since the fishermen are convinced that fish-culture is of value to them, from a business point, they might be further educated so as to be sensible of their own interests.

MR. BISSELL inquired how large such reservations should be.

DR. SWEENY suggested that reservations of three miles in length by a mile in width would be about the proper size.

MR. NEVIN called attention to the fact that whitefish do not always feed where they spawn, and that a good place to plant the young fish was not necessarily a good fishing place.

WORK OF THE WISCONSIN FISH COMMISSION.

BY JAS. NEVIN, SUPERINTENDENT.

The work of artificial propagation of fish in the State of Wisconsin is no longer an experiment in the minds of the people of our State. When the good work of restocking our streams and lakes with their native fish was first attempted we did not meet with much encouragement from many parts of the State. But with perseverance and successful operations the old feeling has vanished, and the cry from all over the State is "more fish," until now we are unable to supply the demand, even to that of German carp.

First in rank comes the pride of all waters, brook trout, and of these fish, most every county in the State has received a portion of the 2,255,000 fry that have been distributed this

present season to 200 applicants, and the supply was insufficient to fill the demand, which at the first of the season was 4,720,000 fry, which were asked for by 286 applicants, and now we have nearly 100 orders on file for next season's distribution, and I dare say this number will swell to 350 orders before the shipping season begins next season.

Next comes California mountain, or rainbow, trout, which have done remarkably well in some parts of the State, and are prized even as high as its rival in beauty and delicacy, the brook trout, while in other parts they rank inferior. These rainbow trout seem to abandon the small streams and seek the larger ones, and the rivers, where they appear to thrive wonderfully. A gentleman of good authority, from St. Croix County, informed me that he caught a two-year-old that tipped the scales at just 4 pounds, and I could relate several instances where they have been taken at that age weighing from 1½ to 3½ pounds. We have just begun the distribution of these fish, and out of the 183 orders now on file I hope to be able to fill 150 of them with about 1,750,000 fry. All orders remaining unfilled, will be filled first, the following season.

Owing to the extreme high water in the Fox river this spring, where I collect my supply of wall-eyed pike eggs, I have been unable to procure a full quota, but have now in the hatching jars at Milwaukee enough to bring forth about 8,000,000 fry, which will be eagerly captured by the 220 applicants whose names are now on file. Since we have begun restocking our numerous lakes we have met with success, and now reap the harvest of our endeavors, by reading *confirmed* reports of success from different parts of the State, and still continue to sow.

The present season I placed in several inland lakes 800,000 Mackinaw, or lake trout, the eggs of which were collected in Lake Michigan, and were hatched at the Madison Hatchery. I do not approve of this method of stocking lakes with lake trout hatched in spring water, for I think it can be done with less labor and expense by collecting large quantities of eggs and carefully spreading them on the shoal reefs of the lakes intended to stock, and let them hatch and take care of themselves.

Our work on whitefish has not been as extensive the past season as formerly, for we were unsuccessful in getting a full amount of eggs, on account of the stormy weather on the lakes last fall, and a few of what we did get were touched by the frost, but have succeeded in hatching 16,000,000 fry, which have been deposited in the waters of Lake Michigan and Green Bay.

It is very gratifying to know that the Wisconsin Fish Commission has at last got the good will of the fishermen around the lakes, and that they are beginning to realize the benefit of the work done by the Commission. There has been more whitefish taken during the past winter and spring, than any season in the last ten years. I heard a fisherman remark the other day that fishing for whitefish was beginning to look like olden times. Ever since the pound net has been in existence, the fishermen have taken out the small whitefish faster than the several hatcheries could put them in. I have seen as high as 2,400 pounds of small fish taken out of one pot, and there were not ten fish in the lot that would weigh a pound each. It is now unlawful in Wisconsin for a man to have in his possession a whitefish of less than one pound, dressed, or one and one-half, undressed, and I am proud to say that the law has given entire satisfaction. The fishermen have always said that whitefish would not live after being caught in the meshes of a net, but last fall, while collecting spawn, I saw thousands caught that had the marks of the nets on them, where they had been previously caught, which proves that whitefish are not the delicate little fellows they have been represented to be.

The value of the lake fishing industry, as reported by the Fish Wardens to the President of the Board, for the year of 1887, are as follows:

Number of pounds caught	4,460,015
Value of fish	$271,269 78
Number of nets	12,750
Value of nets	$161,860 00
Persons employed	1,300
Number of boats	700
Value of boats	$177,285 00

Which shows that the fishing interests of the State of Wisconsin are worth protecting.

In conclusion, I will say a few words on carp and carp ponds. Of all fish I ever tried to catch by seining carp are the most difficult; for when they find themselves surrounded by the net, if they can't get under it they will leap over it. As the temperature of the water at the hatchery was too low to successfully raise carp, the Commission leased a breeding pond, located about two miles from the hatchery, and covering about two acres. In the spring of 1887, I placed in this pond our large carp, and in May had a lot of willows cut and placed in the pond for the fish to spawn on. One day I went to the pond for some large fish for an aquarium, and as the pond could not be drawn down, I thought I could soon catch them by seining. But we seined two days and did not get a large fish. Another day, later in the season, we went to the pond for some fry to ship, and my two little boys, aged five and eight years, went along to pass the time away playing around the pond. Before beginning to fish, I had all the willows taken from the water and placed upon the bank, and, to amuse themselves, the boys rolled some of the willows back into the water. After some time we came to where the brush was to make a haul, and as we began removing it, were surprised to see numerous small fish dart from under the branches. Without taking out any more of the brush, we carefully surrounded it with the net and were very much surprised when we drew it in to take out of it 5,000 small, and fifty large carp. After taking care of the fish, we soon replaced the brush at about a dozen different places around the pond, and in this way we could catch all the fish—either large or small, we wanted, as they seemed to seek the brush for shelter and to hide.

I do not think there would be the large losses of carp in winter, if in the fall people would place a lot of brush in the centre, or deepest part, of their ponds, as the fish would naturally seek the brush and not the shoal water, and thus avoid being frozen in the mud. People who have carp ponds that cannot be drawn down, will find this experiment beneficial in catching their fish as well as serving as a protection.

Madison, Wis.

MR. BARTLETT, of the Illinois Commission, was on the programme for a paper on "Carp in Illinois." He had not prepared the paper, but in a few brief remarks said that the carp had increased and multiplied in his State, and it had produced tons of food from waters which had produced nothing of value heretofore, and the carp was a great boon to the people of Illinois and other States which had no ocean on their borders from which to draw food.

MR. FRED MATHER, a Superintendent of the New York Fish Commission, had been put down for a paper on "Work at Cold Spring Harbor," the station under his charge, but pleaded, with Dr. Sweeny, that he had not been notified that this was to be expected of him. He detailed the work with the different fishes, and said that he had hatched the tomcods in fresh water and had kept them there until the sac was absorbed, and then planted them in brackish water. The experiments with smelt had not brought out any new facts and the limited allowance for his station had not permitted further experiments with salt water fishes. The work of stocking the Hudson with salmon had been continued by the U. S. Commission, of which he was still one of the assistants, as well as one of the State Superintendents, and that the results had been satisfactory. He had built a new hatchery, which he would be pleased to have any of the members visit.

The question of the time and place of the next annual meeting then came up and after some discussion it was decided to accept the motion of Mr. Henry C. Ford to meet in Philadelphia, where he promised that the Anglers' Association of Eastern Pennsylvania would see that the necessary arrangements for entertaining the Society would be attended to. Mr. Bissell moved that the next annual meeting of the Society be held at Philadelphia on the third Wednesday and Thursday of May, 1889, and it was carried.

The election of officers for the following year then came up. Mr. Bissell moved that a nominating committee be appointed, as heretofore. Mr. Mather favored nominations in open meetings, because the committee system had not always worked well, as some of the older members knew. On a vote

it was decided to appoint a committee and Mr. Bissell moved that Dr. Hudson, Mr. Butler, and Mr. Clark be that committee. President May accepted the committee, and they went into private session. The committee recommended the following gentlemen and they were unanimously elected: President, John H. Bissell, Michigan. Vice-President, S. G. Worth, North Carolina. Recording Secretary, Fred Mather, New York. Corresponding Secretary, Henry C. Ford, Pennsylvania. Treasurer, Eugene G. Blackford, New York. Executive Committee, Philo Dunning, Chairman, Wisconsin; S. P. Bartlett, Illinois; Dr. R. O. Sweeny, Minnesota; Dr. W. M. Hudson, Connecticut; C. V. Osborn, Ohio; Col. M. McDonald, Washington, D. C.; and James V. Long, Pennsylvania.

Thanks.

The Society then voted thanks as follows: To the Detroit Lodge of Elks, No. 34, for the use of their room. To the Michigan Fish Commission, for their efforts in making the meeting a success. To Professors Jordan, Forbes, Atwater, and others, not members of the Society, for valuable papers.

The meeting then adjourned until 2 P. M., on the boat which was to take them to the St. Clair Fishing and Shooting Club, by invitation through its President, Mr. W. A. Colburn, as before recorded. A pleasant trip of some twenty-five miles, on the steamer "Milton D. Ward," brought the party to the club house, which is on made ground on the St. Clair Flats, and a dinner which was noted for the excellence of its fish was in readiness. The members of the club showed their guests over the extensive house, and on the return trip it was voted that the club be an honorary member of the American Fisheries Society and receive its annual reports.

THE MEETING ON THE BOAT.

On the return from St. Clair Flats a meeting was organized to hear the report of the Treasurer, who, being unavoidably absent, had mailed his report, which came to the Recording Secretary before the boat left Detroit. This report, which appears elsewhere, was read and accepted.

Dr. Sweeny moved that the Treasurer be authorized to sell the reports, but it was argued that as this was all that absent members got for their dues, such a course would tend to decrease membership. The motion was lost.

Dr. Hudson complained that the last report had been delayed and had only appeared a month before this meeting. Mr. Mather explained that everything was in the printer's hands last August, but that there had been no money in the treasury to pay for it. In view of this fact he had asked Mr. Blackford if it would not be well to increase the annual dues from $3 to $5, but the Treasurer had said that the present sum was ample, if the members would pay their dues promptly.

A long argument was held on the propriety of allowing papers to be printed before they appear in the report, because some editors who never sent a reporter to the meetings, even when held in their own cities, had objected to their publication in *Forest and Stream.* Finally, on motion of Mr. Bissell, Messrs. Mather, Hudson and Ford were appointed a committee in custody of the papers, and to attend to the publication and to use their judgment about selecting a printer and getting the report out at as early a day as possible. They were also to allow such papers to be copied for simultaneous publication in other journals, if it be requested, the expense of copying to be borne by those wishing copies. This committee to meet at Mr. Blackford's, in Fulton Market, on Saturday, June 2, at 12 M.

It was also voted that the printing should be begun by June 1, and that those which are not then on hand shall be omitted, and the meeting adjourned until next year.

During the discussions and the after-dinner speeches on the boat, it cropped out that Mr. Fitzhugh had been quietly taking notes of the animated nature observable about the club house, and he was called on to give the results of his observations. Dr. Hudson, who had been working in a similar line on the St. Clair Flats, stated that the time for scientific observation at the Flats had been too short to make public the hastily-gleaned facts of a naturalist, and to eliminate the personal equation which is always consequent upon hastily

prepared papers, or remarks. Mr. Fitzhugh assented to this, and promised to give the Society the benefit of whatever he may have learned, at some future time.

THE PUBLICATION COMMITTEE.

This Committee, consisting of Messrs. Mather, Ford and Hudson, met at the office of Treasurer E. G. Blackford, on Saturday, June 2, Mr. Blackford being present. A letter from the Michigan Fish Commission, in which the Society was asked to pay for the expense of procuring two papers, from scientific men, was read, the amount being $52.70. It was explained that the Michigan Commission had incurred this expense, in order to contribute to the success of the meeting, without the consent of the Executive Committee. Dr. Hudson moved that the Treasurer notify Mr. Bissell, President of the Michigan Commission, that it was the opinion of the Committee that there was no more money in the Treasury than would pay for the printing of the forthcoming report, and, that if there was a surplus, this Committee had no power to authorize the payment of this bill. Carried.

Dr. Hudson moved that as fast as the proof slips are printed, copies be sent to *Forest and Stream* and the *American Field*. Carried.

Dr. Hudson moved that the Recording Secretary prepare the papers and submit them, with the entire report, to two or more printers, for estimates of the cost of the work, which shall conform in general style of printing, paper and type, to the preceding reports, and that the report shall be ready for mailing by the first of August, 1888. The estimates to be made by the page. Carried, and the meeting adjourned.

The following letter was then sent to Mr. John M. Davis, who has printed the report for several years, Mr. Charles E. Schember, the printer of *Forest and Stream*, and Mr. Martin B. Brown, the Public Printer of New York City:

COLD SPRING HARBOR, N. Y., June 16, 1888.

DEAR SIR—The American Fisheries Society has ordered me to prepare the papers read at the last meeting and to sub-

mit them to two or more printers, for estimates of the cost of publishing. The report to be ready for mailing by August 1, 1888, and to conform in size, paper and type, to preceding reports, the estimates to be per page.

Four proof slips to be sent me, one of which will be returned, after correction, by either the author, or myself.

If you care to give an estimate on this work, I will submit the papers and a copy of the last report to you.

The new report will be larger than the last one, and only 300 copies will be printed.

Very truly yours,

FRED MATHER,

Recording Secretary.

Mr. Schember did not reply. Mr. Davis offered to do the work for $1.50 per page, with extra charge for tables. Mr. Brown agreed to do it for $1.45 per page, with no extra charge, and the printing was awarded to him.

TREASURER'S REPORT.

NEW YORK, May 10, 1888.

THE AMERICAN FISHERIES SOCIETY,

In account with EUGENE G. BLACKFORD, *Treasurer.*

Receipts.

1888.			
May 10.	Total receipts from Membership Dues		$267 00

Disbursements.

1887.				
May 28.	J. M. Davis, printing notices of meeting	$2 00		
1888.				
March 27.	" " postal cards	7 50		
April 6.	" " reports	112 00		
" 6.	175 stamped wrappers	3 68		
		$125 18		
	Balance due Treasurer at last meeting	80 17		
			205 35	
	Balance in Treasurer's hands			$61 65

MEMBERS

OF THE

AMERICAN FISHERIES SOCIETY.

Honorary Members.

Frederick III., Emperor of Germany.

Behr, E. von, Schmoldow, Germany; President of the Deutschen Fischerei Verein, Berlin, Germany.

Borne, Max von dem, Berneuchen, Germany.

Huxley, Prof. Thomas H., London; President of the Royal Society.

Jones, John D., 51 Wall Street, New York.

St. Clair Flats Shooting and Fishing Club, Detroit, Mich.

Corresponding Members.

Apostolides, Prof. Nicoly Chr., Athens, Greece.

Buch, Dr. S. A., Christiana, Norway; Government Inspector of Fisheries.

Birkbeck, Edward, Esq., M. P., London, England.

Benecke, Prof. B., Königsberg, Germany; Commissioner of Fisheries.

Brady, Thomas F., Esq., Dublin Castle, Dublin, Ireland; Inspector of Fisheries for Ireland.

Chambers, Oldham W., Esq., Secretary of the National Fish-Culture Association, South Kensington, London.

Day, Dr. Francis, F. L. S., Kenilworth House, Cheltenham, England; late Inspector-General of Fisheries for India.

Feddersen, Arthur, Viborg, Denmark.

Giglioli, Prof. H. H., Florence, Italy.

Hubrecht, Prof. A. A. W., Utrecht, Holland; Member of the Dutch Fisheries Commission, and Director of the Netherlands Zoölogical Station.

K. Ito, Esq., Hokkaido, Cho., Sapporo, Japan; Member of the Fisheries Department of Hokkaido, and President of the Fisheries Society of Northern Japan.

Juel, Capt. N., R. N., Bergen, Norway; President of the Society for the Development of Norwegian Fisheries.

Landmark, S., Bergen, Norway; Inspector of Norwegian Fresh-water Fisheries

Lundberg, Dr. Rudolf, Stockholm, Sweden; Inspector of Fisheries.

Maitland, Sir J. Ramsay Gibson, Bart., Howietown, Stirling, Scotland.

Marston, R. B., Esq., London, England; Editor of the *Fishing Gazette*.

Macleay, William, Sydney, N. S. W.; President of the Fisheries Commission of New South Wales.

Sars, Prof. G. O., Christiana, Norway; Government Inspector of Fisheries.

Solsky, Baron N. de, St. Petersburg, Russia; Director of the Imperial Agricultural Museum.

Sola, Don Francisco, Garcia, Madrid, Spain; Secretary of the Spanish Fisheries Society.

Wattel, M. Raveret, Paris, France; Secretary of the Société d'Acclimation.

Young, Archibald, Esq., Edinburgh, Scotland; H. M. Inspector of Salmon Fisheries.

Walpole, Hon. Spencer, Governor of the Isle of Man.

Deceased Members.

Baird, Hon. Spencer F.
Carman, G.
Chappel, George.
Develin, John E.
Garlick, Dr. Theodatus.
Lawrence, Alfred N.
McGovern, H. D.
Parker, W. R.
Redding, B. B.
Redding, George H.
Rice, Prof. H. J.
Smith, Greene.
Shultz, Theodore.

Members.

Persons elected at last meeting and who did not pay their dues do not appear in this list.

Adams, Dr. S. C., Peoria, Ill.
Agnew, John T., 284 Front Street, New York.
Anderson, A. A., Bloomsbury, N. J.
Annin, James, Jr., Caledonia, N. Y.
Atkins, Charles G., Bucksport, Me.
Atwater, Prof. W. O., Middletown, Conn.

Barrett, Charles, Grafton, Vt.
Bartlett, S. P., Quincy, Ill.
Bean, Dr. Tarleton H., National Museum, Washington, D. C.
Belmont, Perry, 19 Nassau Street, New York.
Benjamin, Pulaski, Fulton Market, New York.
Benkard, James, Union Club, New York.
Bickmore, Prof. A. S., American Museum, New York.

Bissell, J. H., Detroit, Mich.
Blackford, E. G., Fulton Market, New York.
Booth, A., Chicago, Ill.
Bottemane, C. J., Bergen-op-Zoom, Holland.
Brown, J. E., U. S. Fish Commission, Washington, D. C.
Brown, S. C., National Museum, Washington, D. C.
Bryan, Edward H., Smithsonian Institution.
Bryson, Col. M. A., 903 Sixth Avenue, New York.
Butler, W. A., Jr., Detroit, Mich.
Butler, Frank A., 291 Broadway, New York.
Butler, W. H., 291 Broadway, New York.

Carey, Dr. H. H., Atlanta, Ga.
Cheney, A. Nelson, Glen Falls, N. Y.
Clapp, A. T., Sunbury, Pa.
Clark, Frank N., U. S. Fish Commission, Northville, Mich.
Clark, A. Howard, National Museum, Washington, D. C.
Comstock, Oscar, Fulton Market, New York.
Conklin, William A., Central Park, New York.
Cox, W. V., National Museum, Washington, D. C.
Crook, Abel, 99 Nassau Street, New York.
Crosby, Henry F., P. O. Box 3714, New York City.

Dewey, J. N., Toledo, O.
Dieckerman, George H., New Hampton, N. H.
Donaldson, Hon. Thomas, Philadelphia, Pa.
Dunning, Philo, Madison, Wis.

Earll, R. E., National Museum, Washington, D. C.
Ellis, J. F., U. S. Fish Commission, Washington, D. C.
Endicott, Francis, Tompkinsville, N. Y.
Evarts, Charles B., Windsor, Vt.

Fairbank, N. K., Chicago, Ill.
Ferguson, T. B., Washington, D. C
Fitzhugh, Daniel H., Bay City, Mich.
Foord, John, Brooklyn, N. Y.
Ford, Henry C., Philadelphia, Pa.
French, Asa B., South Baintree, Mass.

Garrett, W. E., P. O. Box 3006, New York.
Gilbert, W. L., Plymouth, Mass.
Goode, G. Brown, National Museum, Washington, D. C.

Habershaw, Frederick, 113 Maiden Lane, New York.
Haley, Albert, Fulton Market, New York.
Haley, Caleb, Fulton Market, New York.

Hall, G. W., Union Club, New York.
Harris, Gwynn, Washington, D. C.
Harris, W. C., 252 Broadway, New York.
Hayes, A. A., Washington, D. C.
Henshall, Dr. J. A., 362 Court Street, Cincinnati, O.
Hessel, Rudolf, U. S. Fish Commission, Washington, D. C.
Hicks, John D., Roslyn, Long Island, N. Y.
Hill, M. B., Clayton, N. Y.
Hinchman, C. C., Detroit, Mich.
Hofer, J. C., Bellaire, O.
Hudson, Dr. William M., Hartford, Conn.
Humphries, Dr. E. W., Salisbury, Md.
Hutchinson, E. S., Washington, D. C.

Isaacs, Montefiore, 42 Broad Street, New York.

Jessup, F. J., 88 Cortlandt Street, New York.
Johnston, S. M., Battery Wharf, Boston, Mass.

Kauffman, S. H., *Evening Star* Office, Washington, D. C.
Kelly, P., 346 Sixth Avenue, New York.
Kellogg, A. J., Detroit, Mich.
Kingsbury, Dr. C. A., 1119 Walnut Street, Philadelphia, Pa.

Lawrence, G. N., 45 East 21st Street, New York.
Lawrence, F. C., Union Club, New York.
Lee, Thomas, U. S. Fish Commission.
Long, James Vernor, Pittsburgh, Pa.
Loring, John A., 3 Pemberton Square (Room 8), Boston, Mass.
Lowrey, J. A., Union Club, New York.
Lydecker, Major G. I., U. S. Engineers.

Mallory, Charles, foot Burling Slip, New York.
Mansfield, Lieut. H. B., U. S. Navy, Washington, D. C.
Mather, Fred, Cold Spring Harbor, Suffolk Co., N. Y.
Marks, Walter D., Paris, Mich.
May, W. L., Fremont, Neb.
McDonald, Col. M., Fish Commissioner of the United States, Washington, D. C.
McGown, Hon. H. P., 76 Nassau Street, New York.
Middleton, W., Fulton Market, New York.
Milbank, S. W., Union Club, New York.
Miller, S. B., Fulton Market, New York.
Miller, Ernest, Fulton Market, New York.
Moore, George H. H., U. S. Fish Commission.

Nevin, James, Madison, Wis.

O'Brien, Martin E., South Bend, Neb.
O'Connor, J. J., U. S. Fish Commission, Washington, D. C.
Osborn, Hon. C. V., Dayton, O.

Page, George S., 49 Wall Street, New York.
Page, W. F., U. S. Fish Commission, Washington, D. C.
Parker, Dr. J. C., Grand Rapids, Mich.
Parker, Peter, Jr., U. S. Fish Commission.
Pease, Charles, East Rockport, Cuyahoga Co., O.
Pike, Hon. R. G., Middletown, Conn.
Post, W., Knickerbocker Club, New York.
Powell, W. L., Harrisburg, Pa.

Ray, Hon. Ossian, M. C., New Hampshire.
Redmond, R., 113 Franklin Street, New York.
Reinecke, Theodore, Box 1651, New York.
Reynal, J., 84 White Street, New York.
Reynolds, Charles B., 318 Broadway, New York.
Ricardo, George, Hackensack, N. J.
Robeson, Hon. Geo. M., Camden, N. J.
Ryer, F. R., Bellport, N. Y.

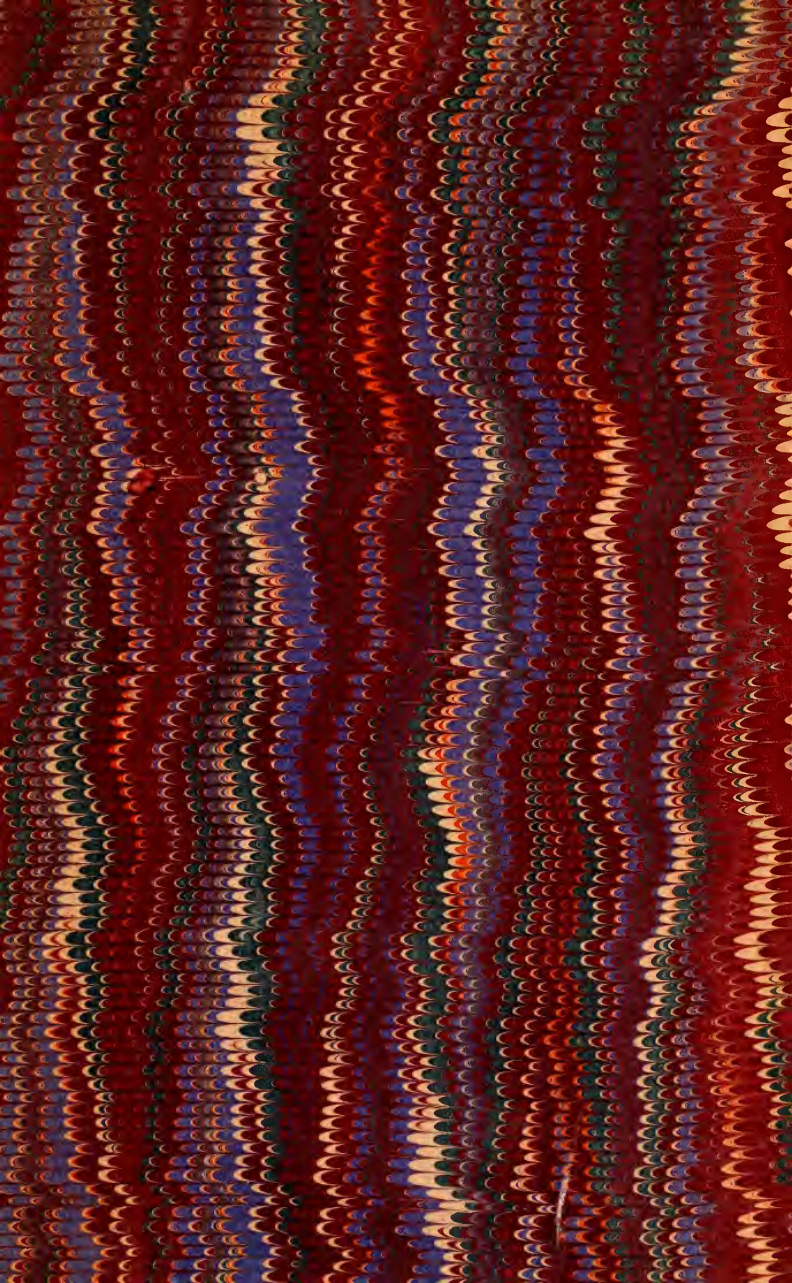
Schaffer, George H., foot Perry Street, New York.
Schieffelin, W. H., 170 William Street, New York.
Schuyler, H. P., Troy, N. Y.
Sherman, Gen. R. U., New Hartford, Oneida Co., N. Y.
Simmons, Newton, U. S. Fish Commission, Washington, D. C.
Smiley, C. W., Smithsonian Institution, Washington, D. C.
Spensley, Calvert, Mineral Point, Wis.
Spofford, Henry W., Smithsonian Institution.
Steers, Henry, 10 East 38th Street, New York.
Stone, Livingston, Charlestown, N. H.
Stone, Summer R., 58 Pine Street, New York.
Swan, B. L., Jr., 5 West 20th Street, New York.
Sweeny, Dr. R. O., St. Paul, Minn.

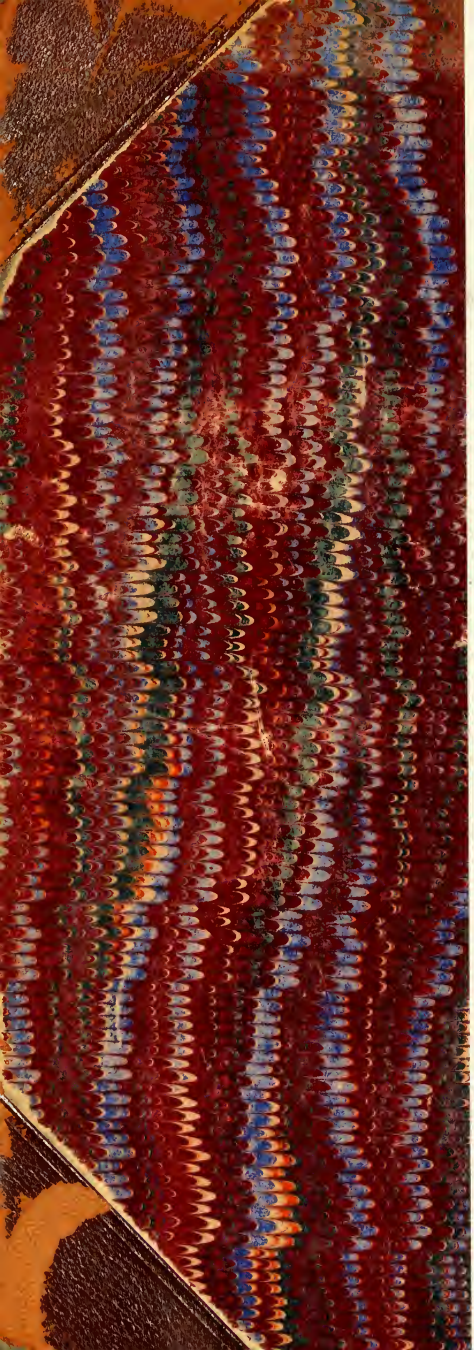
Thompson, H. H., Bedford Bank, Brooklyn, N. Y.
Tomlin, David W., Duluth, Mich.

Ward, George E., 43 South Street, New York.
Weeks, Seth, Corry, Erie Co., Pa.
West, Benjamin, Fulton Street, New York.
Whitaker, Herschel, Detroit, Mich.
Whitney, Samuel, Katonah, N. Y.
Wilbur, E. R., 39–40 Park Row, New York.
Wilcox, Joseph, Media, Pa.

Wilcox, W. A., 176 Atlantic Avenue, Boston, Mass.
Willets, J. C., Skaneateles, N. Y., or 1 Grace Court, Brooklyn.
Williams, A. C., Chagrin Falls, O.
Wilmot, Samuel, Newcastle, Ontario.
Wilson, J. P., U. S. Fish Commission.
Wood, Benjamin, 25 Park Row, New York.
Woodruff, G. D., Sherman, Conn.
Woods, Israel, Fulton Market, New York.
Worth, S. G., U. S. Fish Commission, Washington, D. C.

Tompkins





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